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UNITED STATES DEPARTMENT OF AGRICULTURE

BULLETIN No. 878

Contribution from the Bureau of Plant Industry
WM. A. TAYLOR, Chief

Washington, D. C. PROFESSIONAL PAPER November 9, 1920

VARIETAL EXPERIMENTS WITH SPRING WHEAT ON THE NORTHERN GREAT PLAINS

By

J. ALLEN CLARK, Agronomist in Charge, JOHN H. MARTIN, Assistant Agronomist, and RALPH W. SMITH, Scientific Assistant, Western Wheat Investigations, Office of Cereal Investigations

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SCOPE OF THE INVESTIGATIONS.

The purpose of this bulletin is to present the results obtained to date [1] from varietal experiments with spring wheat at 11 field stations in the northern half of the Great Plains area. What the principal varieties are, how and when they came to be, and how to tell them apart are stated. The particular section or district for which certain varieties are recommended is given also, and the yields, agronomic factors, and milling values of the varieties are discussed.

In this northern Great Plains area severe losses have occurred recently, due to drought, blight, rust, and scab. Land values, however, have risen in about the same proportion as in other sections, and with the increased cost of production and higher prices obtained for wheat the growing of poorly adapted varieties has become much more unprofitable than formerly. This has increased the demand for information on comparative yields of varieties and their resistance to disease.

[1] A list of publications showing the results of earlier experiments is given at the end of this bulletin.

SOURCES OF EXPERIMENTAL DATA.[2]

The experimental data have been obtained from three sources: Experiments conducted cooperatively by the Bureau of Plant Industry and the State agricultural experiment stations, experiments conducted independently by the Bureau of Plant Industry, and experiments conducted independently by the State agricultural experiment stations.

The data from the following stations were obtained in cooperation with the State agricultural experiment stations: Williston and Dickinson, N. Dak.; Havre and Moccasin, Mont.; Highmore and Newell, S. Dak.; and Sheridan and Archer, Wyo. At Newell, S. Dak., the station is operated by the Office of Western Irrigation Agriculture, and at Mandan, N. Dak., Akron, Colo., and Sheridan, Wyo., the stations are conducted by the Office of Dry-Land Agriculture, the Office of Cereal Investigations cooperating in the experiments with cereals. At North Platte, Nebr., the data were obtained independently by the Nebraska Agricultural Experiment Station.

VARIETIES.

Hundreds of varieties of wheat of foreign and domestic origin have been obtained by the United States Department of Agriculture. In preliminary nursery experiments most of these, however, have not proved adapted to this semiarid section. Those which have shown promise have been grown in plat experiments. The results of these experiments obtained in recent years are presented in this bulletin. The origin of the varieties is stated and, for convenience in presenting the experimental results, the varieties usually have been arranged in closely related groups.

STRAINS OF COMMON AND DURUM WHEAT.

All of the varieties of spring wheat which have shown promise in the northern Great Plains area belong to two main divisions or species—common wheat (*Triticum vulgare*) and durum wheat (*Triticum durum*). As shown by the key, common wheat can be distinguished from durum wheat by the more slender spikes, by the shorter awns or absence of awns, by the looser spikes, by the spike being flattened parallel to the face of the spikelets, and by the smaller kernels.

The origins of the principal varieties of both common and durum wheats are briefly given. Differences or similarities of closely related strains also are indicated. Heads of important commercial varieties of common and durum wheat are shown in Plate I, and grains of several of these varieties are shown in Plate II.

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[2] The men who have been in charge of the cereal experiments at the various stations since 1913 are as follows: *North Dakota.*—Williston, F. R. Babcock; Dickinson, J. A. Clark and R. W. Smith; Mandan, J. C. Brinsmade, jr. *Montana.*—Havre, G. W. Morgan; Moccasin, N. C. Donaldson and P. V. Cardon. *South Dakota.*—Highmore, J. D. Morrison and E. S. McFadden; Newell, S. C. Salmon, J. H. Martin, and A. D. Ellison. *Wyoming.*—Sheridan, L. D. Willey; Archer, J. W. Jones, V. H. Florell, and A. L. Nelson. *Nebraska.*—North Platte, L. L. Zook. *Colorado.*—Akron, C. H. Clark, G. A. McMurdo, and F. A. Coffman.

KEY TO GROUPS OF SPRING WHEAT.

Below is given a key to the groups of spring wheat discussed in this bulletin.

DESCRIPTIVE KEY TO GROUPS OF COMMON AND DURUM WHEAT.

Spikes usually slender, awnless or awns less than 3 inches long; spikelets widely separated, scarcely overlapping, flattened parallel to the face of the spikelets; kernels small to midsized, soft to hard.....*Common wheat.*
- Spike awnless.
  - Glumes glabrous, white.
    - Kernels red.....*Fife group.*
  - Glumes pubescent, white.
    - Kernels red.....*Bluestem group.*
- Spike awned.
  - Glumes glabrous, white.
    - Kernels red.....*Preston group.*
  - Glumes glabrous, brown.
    - Kernels red.....*Ladoga group.*

Spikes usually stout, all awned, awns 4 to 8 inches long; spikelets crowded, much overlapping, flattened at right angles to the face of the spikelets; kernels midsized to large, hard.....*Durum wheat.*
- Spike awned.
  - Glumes glabrous, white or yellowish.
    - Awns white or yellowish.
      - Kernels white (amber), large.....*Kubanka group.*
      - Kernels red, midsized.....*Red Durum group.*
    - Awns black.
      - Kernels white (amber), very large.....*Peliss group.*

COMMON WHEAT.

Common wheat has been grown longer than durum wheat on the northern Great Plains and makes up the larger percentage of the spring-wheat acreage. Most of the varieties of common wheat grown there have red kernels, which are usually hard and of high milling quality. Varieties of the Fife group are the most extensively grown.

THE FIFE GROUP.

The wheats included in the Fife group are similar in appearance, and most of them are closely related. The heads are awnless and rather slender to medium stout. In general, they vary in length from 3 to 3½ or 4 inches. The glumes are white and glabrous, and the kernels are small to medium in size, red in color, and hard. The principal varieties are described in the following paragraphs, the most important being listed first.

Marquis.—The Marquis is the leading variety included in the Fife group. It has been grown in the United States only since about 1913, but during the past seven years it has been introduced into most of the spring-wheat producing sections. In the northern Great Plains area it is grown on a greater acreage than all other spring wheats combined. The value of any other variety is now dependent upon how it compares with Marquis wheat. For this reason the Marquis variety is used in this bulletin as a standard of comparison.

The Marquis is a selection from a hybrid produced by crossing a hard red wheat from Calcutta, India, and the well-known Red Fife. This cross was made by Dr. A. P. Saunders about 1892. The Marquis was selected and named by Dr. C. E. Saunders, Dominion Cerealist, and was first grown as a pure line at Ottawa, Canada, in 1904. It resembles the Red Fife except that the culms, spikes, glumes, and kernels are somewhat shorter, the glumes are more persistent, and the plant matures earlier.

Red Fife.—The original Red Fife wheat is supposed to have come from Russia by way of Germany and Scotland. About 75 years ago a Mr. David Fife, of Otonabee, Ontario, Canada, received a small sample of wheat from a friend in Glasgow, Scotland. The friend had obtained the sample from a shipload of wheat from Germany, but supposedly of Russian origin. Mr. Fife sowed the wheat in the spring, but it proved to be a winter wheat. However, a plant of spring wheat developed in the plat, and this was saved and increased. This wheat became widely grown in Canada and known as Red Fife. It has been grown in the United States since the early development of the northern Great Plains area, but in this country has been known more generally as Fife, Scotch Fife, Canadian Fife, and Saskatchewan Fife. From these have arisen strains developed by farmers and experiment stations, which made up a large part of the spring wheat of America until replaced by the Marquis variety. Of the two lots of Red Fife wheat listed in this bulletin, C. I. No. 3329 was obtained from the Brandon Experiment Farm, Brandon, Manitoba, Canada, while C. I. No. 3694 represents commercial stocks grown in North Dakota.

Power.—The stock known as Power (Power Fife) was started about 1885 by Mr. James Holes, of Fargo, N. Dak., from a single plant of Red Fife wheat found growing in an oat field. Some of this seed was obtained by Mr. J. B. Power, of Power, N. Dak., who increased it and distributed it in large quantities; hence the name.

Seed from Mr. Power was called No. 66 by the North Dakota Agricultural Experiment Station and distributed quite widely through North Dakota in the nineties as "Station No. 66." In 1892 selections were made from it at the North Dakota station at Fargo, and in recent years one of these selections (N. Dak. No. 313; C. I. No. 3697) has been grown in preference to the original stock. This strain appears to be very similar to the Red Fife (C. I. No. 3329) from Canada.

Glyndon.—The Glyndon strain of Red Fife dates at least from 1891, when it was first grown as No. 811 at the Glyndon Experiment Farm in western Minnesota. In the burning of the Glyndon station buildings all record of its origin was lost. Without doubt, however, it was one of the many samples of Red Fife wheat obtained from Minnesota farmers in 1888 and 1889. The Glyndon differs from the Power and Red Fife wheats in being slightly taller and in having longer and more tapering spikes and longer kernels.

In 1892 a selection of this Glyndon No. 811 was made and later given Minnesota station number 163 (C. I. No. 2873). It was grown and distributed by the Minnesota Agricultural Experiment Station for many years as "Minnesota No. 163," but by 1914 was named Glyndon.

Rysting.—Rysting (Rysting Fife) was developed about 1892 by Mr. Jens Rysting, of Buxton, N. Dak. Mr. Rysting had been selecting this wheat for several years and claimed that it was earlier than ordinary Red Fife. The Rysting and the Glyndon varieties are nearly alike.

Early Red Fife.—Early Red Fife is an early-ripening selection of the original Red Fife wheat made by Dr. C. E. Saunders at the Central Experiment Farm, Ottawa, Canada.

Kitchener.—Kitchener wheat is a result of a selection from a field of the Marquis variety made by Mr. Seager Wheeler of Rosthern, Saskatchewan, Canada, who first distributed it in 1916. It differs from Marquis wheat in being somewhat later and taller and in having purple straw and a clavate spike.

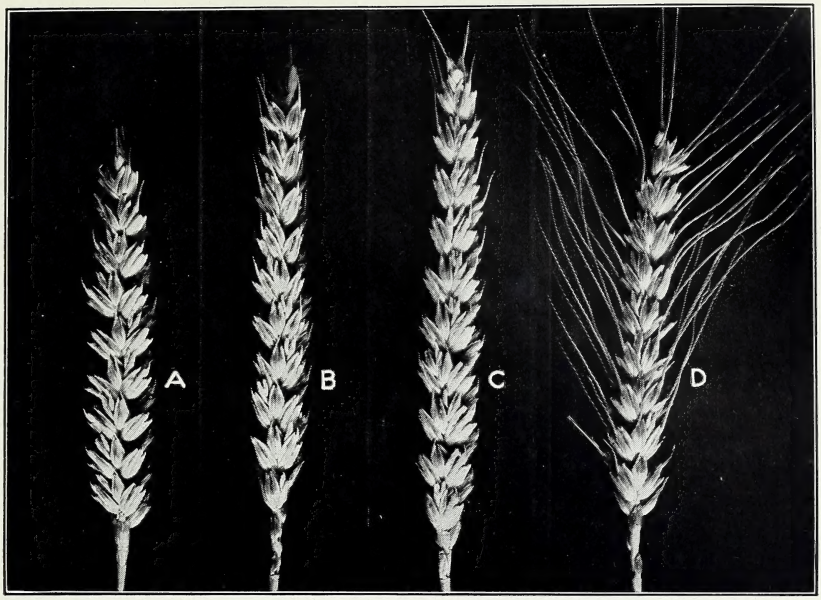


FIG. 1.—HEADS OF COMMON WHEATS.

A, Marquis; *B*, Power Fife; *C*, Haynes Bluestem; *D*, Preston. About half natural size.

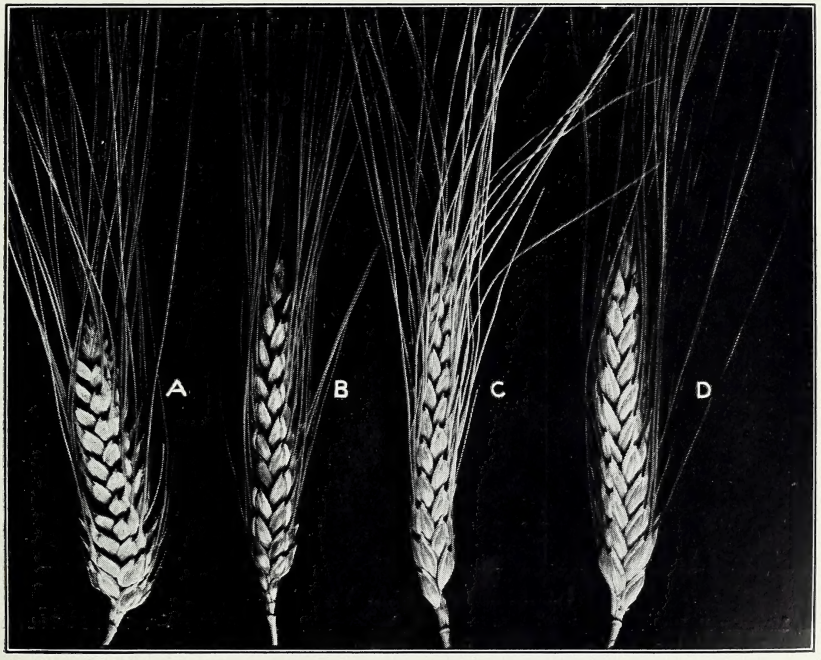
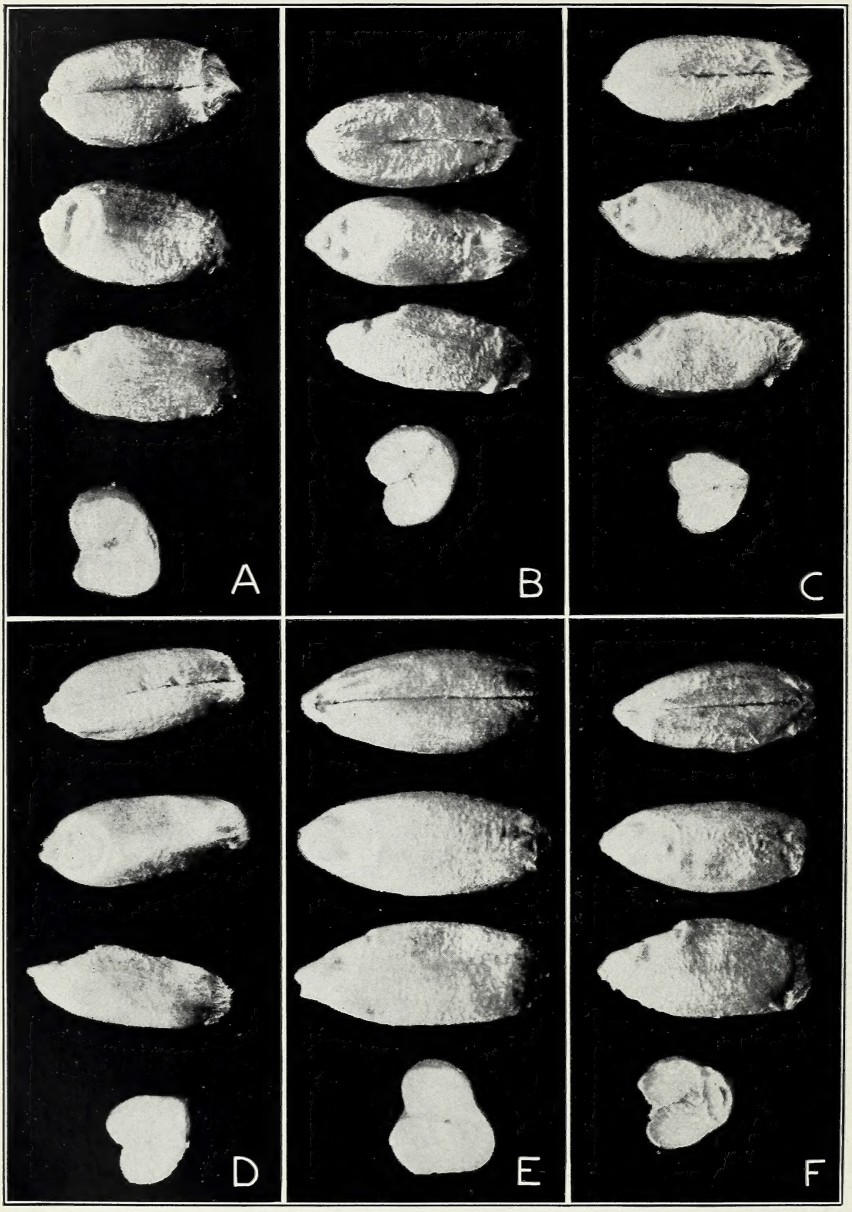


FIG. 2.—HEADS OF DURUM WHEATS.

A, Kubanka; *B*, Arnautka; *C*, D-5; *D*, Peliss. About half natural size.



KERNELS OF WHEAT VARIETIES.

A, Marquis; *B*, Red Fife; *C*, Haynes Bluestem; *D*, Preston; *E*, Arnautka; *F*, D-5. Magnified about five diameters.

Ruby.—Ruby wheat was originated by Dr. C. E. Saunders, of the Central Experiment Farm, Ottawa, Canada, from a cross between Downy Riga and Red Fife and was first distributed in 1917. It is earlier and differs somewhat in appearance from the Marquis variety.

Ghirka Spring.—The Ghirka Spring wheat (C. I. No. 1517) came from Grodno Province in Russian Poland and was obtained by the United States Department of Agriculture in 1900. It differs from the true Red Fife in having long, tapering spikes, purple straw, and a midsized, semihard, pale-red kernel.

THE BLUESTEM GROUP.

The varieties of the Bluestem group of hard red spring wheats are all very similar in appearance. They also are very closely related in origin. The Bluestem wheats of the South Atlantic and Eastern States and the Pacific Bluestem of the Pacific Northwest belong to very different groups and should not be confused with these hard red spring Bluestems.

The wheats here discussed are of medium height and rather more vigorous in growth than the Fife wheats. The heads are beardless, with pubescent white glumes and are rather broader than those of the Fifes. The kernels are hard, red, plump, and of medium size. The chaff is more loose and open than in the Fife wheats, and the kernels shatter easily if the crop becomes overripe.

The word Bluestem is used commonly as a name for the whole group and also as a name for the variety on any given farm. This is correct in most cases, as there are no really distinct varieties in this group. However, the pure lines being grown are called by varietal names, such as Dakota, Haynes, etc.

Haynes.—The well-known Haynes strain originated with Mr. L. H. Haynes, of Fargo, N. Dak., about 1882, when he started with an ordinary lot of Bluestem wheat. During 8 or 10 years he carefully selected his wheat for good plants, good heads, and good kernels, and distributed seed widely from 1892 to 1895. The Minnesota Agricultural Experiment Station obtained the wheat, calling it Minnesota No. 51 (C. I. No. 3021), from which was developed a pure line which was designated as Minnesota No. 169 (C. I. Nos. 2874 and 3020) and distributed widely.

Dakota.—The pure-line Dakota variety originated at the North Dakota Agricultural Experiment Station about 1898. It was selected from the original Haynes, which probably was not a pure line. It was first called by its number, North Dakota No. 316, later by the name Select Bluestem, and finally was named Dakota.

Crossbred.—This Bluestem strain was produced from a cross between two plants of Bluestem wheat made by Prof. W. M. Hays at the North Dakota Agricultural Experiment Station in 1893.

Marvel.—The name Marvel was applied to Bluestem wheat distributed by the John A. Salzer Seed Co., of La Crosse, Wis.

THE PRESTON GROUP.

The Preston group is made up of bearded common wheats with glabrous white glumes. The kernels are red, of medium size and plumpness, and are hard or fairly hard. The Preston wheats differ from the Fife wheats most noticeably in being bearded.

Varieties of this group of wheat usually are called "Bearded Fife" and "Velvet Chaff." The name Preston is preferable, because most of the bearded hard red spring wheat grown probably is of the Preston variety, and none of the varieties has hairy chaff.

Preston.—The Preston variety was selected from a cross between Ladoga, a Siberian wheat, and Red Fife made by the late Dr. William Saunders, of Ottawa, Canada, in 1888. It is a bearded spring common wheat with glabrous white chaff and midsized red and fairly hard kernels. It can be distinguished from other members of the Preston group by the much shorter beaks on the outer glumes. These beaks are only one-sixteenth to three-sixteenths of an inch long.

The Preston wheat has been grown at Indian Head, Saskatchewan, Canada, since 1893. It was first grown by the Minnesota Agricultural Experiment Station in 1895 and called Minnesota No. 188. It was widely distributed under this number instead of under the name Preston. About 10 years later a similar wheat came on the market under various names, such as "Bearded Fife," "Red Fife," and "Velvet Chaff." Apparently these were all the same wheat and were identical with Preston. The name "Velvet Chaff" is especially misleading, because all these wheats have smooth or glabrous chaff, while some very different wheats with pubescent or hairy chaff are called Velvet Chaff. The names "Bearded Fife" and "Red Fife" are also misleading, as the variety is not really a Fife wheat. The name "Velvet Chaff" was originally used for Cereal Investigations Nos. 3081 and 4153, "Bearded Fife" for Cereal Investigations No. 3087, and "Red Fife" for Cereal Investigations No. 3698, all coming from commercial fields in Minnesota or the Dakotas. Only Cereal Investigations No. 2958, coming from the Central Experiment Farm, Ottawa, Canada, is known to be the true Preston.

Converse.—The name Converse is here given to a commercial variety of spring wheat grown in Wyoming under the name "Red Russian," which name is used for three other wheat varieties in the United States, so a new name has now been chosen for this variety. The original sample was obtained by a representative of the Department of Agriculture from Converse County, Wyo.; hence the name. It differs from Preston in being taller and earlier and in having longer beaks and soft instead of hard kernels.

Erivan.—The Erivan variety was introduced by the United States Department of Agriculture in 1903 from the dry mountainous district of the Erivan Government in Transcaucasian Russia, near the border of Persia. It differs from the Preston variety in having shorter, weaker straw, in earlier maturity, in the longer beaks on the outer glumes, and in the somewhat softer kernels.

Fretes.—The Fretes variety was obtained in Algeria, but it is almost certainly of Russian origin. It is quite similar to Erivan except that the kernels are larger.

Kota.—The Kota variety was obtained in Russia by Prof. H. L. Bolley, of the North Dakota Agricultural College, in 1903. It was introduced either as a separate lot, later designated as R. B. R. 3, or as a mixture in a sample of durum wheat. It recently was separated from Monad durum wheat, found to be resistant to black stem rust, and named Kota by Waldron and Clark.[3] It differs from the Preston wheat in having weaker straw and longer beaks and a more elevated shoulder on the outer glumes.

Pioneer.—The Pioneer variety was originated from a cross between Riga and Preston, made by Dr. C. E. Saunders, in 1903, at the Central Experiment Farm, Ottawa, Canada. It differs from the Preston wheat chiefly in being earlier.

[3] Waldron, L. R., and Clark, J. A. Kota, a rust-resisting variety of common spring wheat. *In* Jour. Amer. Soc. Agron., v. 11, no. 5, pp. 187–195. 1919.

THE LADOGA GROUP.

The varieties of wheat here included in the Ladoga group have bearded spikes, glabrous brown glumes, and red kernels. The varieties are not all closely related.

Ladoga.—The Ladoga variety was obtained in 1888 from Ladoga, Siberia, by the Canadian Government, which distributed seed in quantity through the spring-wheat sections of Canada. This is probably the origin of the wheat grown in Montana and Wyoming, usually as mixtures, under the name of "Spring Turkey," as the two varieties are quite similar in appearance. The name "Spring Turkey" is incorrect and misleading, so is not here used. The Ladoga variety listed in this bulletin is the commercial wheat obtained from southeast Wyoming, under the name of "Spring Turkey."

Laramie.—The Laramie variety is a pure-line selection of Ladoga made by J. W. Jones, of the United States Department of Agriculture, at the Cheyenne Experiment Farm, Archer, Wyo., in 1914. The wheat was named for Laramie County, Wyo.

Huron.—The Huron variety is a selection from a hybrid between the Ladoga and the White Fife wheats made about 1890, at Ottawa, Canada. It is very similar to the true Ladoga.

Norka.—The Norka variety originated from a pure-line selection of common wheat separated from a plat of Kubanka durum wheat in 1908 by W. G. Shelley, a representative of the United States Department of Agriculture at Akron, Colo. It is very similar to the Laramie variety, but has a harder kernel. The name is the reverse spelling of Akron.

Changli.—The Changli variety was introduced from Changli, China, by the United States Department of Agriculture. It differs from the Ladoga and Huron varieties in being much earlier and in having softer kernels.

Manchuria.—The Manchuria variety was received from Manchuria in 1904. It also is earlier and has softer kernels than the Ladoga, but is taller than Changli wheat.

MISCELLANEOUS COMMON WHEATS.

The following varieties of common wheat can not be included in any of the preceding groups and are here listed as miscellaneous varieties. The varieties belong to several different types of wheat.

Prelude.—The Prelude variety originated from a cross made by Dr. C. E. Saunders at the Central Experiment Farm, Ottawa, Canada, in 1903, between a hybrid wheat named Fraser and a very early wheat from India called Gehun. It was first distributed in 1914. It is a very early wheat with short straw. It is awned and has pubescent yellowish glumes and red, small, hard kernels. It shatters badly when fully ripe; hence, it should always be cut while it is still somewhat green.

Galgalos.—The Galgalos variety is awnless, with pubescent brown glumes, and white, midsized, soft kernels. It came from the Erivan Government in the Transcaucasus district of Russia, between the Black and Caspian Seas. There it is grown as a dry-land spring wheat, and it has been so grown here except in certain sections of the Pacific coast area, where it is grown successfully as a winter wheat. Because it is a soft white wheat it is not desirable for growing in the hard spring-wheat district.

Regenerated Defiance.—The Regenerated Defiance variety originated from a selection of Defiance wheat made at the Colorado Agricultural Experiment Station and distributed about 1910. It is awnless, with glabrous white glumes and white, small, hard kernels. It has proved best adapted for growing under irrigation.

Humpback.—The Humpback variety originated from field selections made by J. P. Berglund, a farmer living near Kensington, Minn. The original head was probably the result of a natural field hybrid. Two strains were developed. The first, dis-

tributed about 1905, was awned, with pubescent white glumes and a red, midsized, humped, semihard kernel. The second strain, distributed a few years later, has glabrous glumes, but otherwise is not greatly different from the first. In this bulletin the second strain is called Humpback II.

DURUM WHEAT.

Durum wheat can be distinguished from common wheat chiefly by the flattening of the spike at right angles to the face of the spikelets, instead of parallel, as in common wheat. The spikes usually also are shorter and denser and the awns longer. All durum wheat varieties have awns, except a few awnless strains developed through breeding.

THE KUBANKA GROUP.

Most of the important commercial varieties of durum wheat grown in the United States are included in the Kubanka group. This group has yellowish awns, glabrous, yellowish glumes, and large white or amber kernels.

Kubanka.—The Kubanka is the best known variety of durum wheat in this country. The principal introduction of this variety was made by Mr. M. A. Carleton, cerealist of the United States Department of Agriculture, in 1900, from the Uralsk Government in Russia. That importation (C. I. No. 1440; S. P. I. No. 5639 [4]) has become widely grown, especially in western North Dakota and in South Dakota. Many pure-line selections have been made from it. Several are reported in this bulletin. Selection Nos. 8 (C. I. No. 4063) and 98 (C. I. No. 6519) were made at the Dickinson Substation, Dickinson, N. Dak., and Selection Nos. 712 and 715 were made at the Belle Fourche Experiment Farm, Newell, S. Dak.

Several other introductions of the variety have been made. Yields for two of these (C. I. Nos. 1354 and 1516) are here reported. They were both obtained from the Samara Government, Russia. Other introductions of similar wheat were made under other names. Those that are reported in this bulletin are Beloturka, Gharnovka, and Pererodka, all very similar to the Kubanka.

The Beloturka variety was obtained at the Paris Exposition, but undoubtedly is of Russian origin. The name, in Russian, means White Turkish.

The Gharnovka variety was obtained in three lots from Taganrog, Province of the Don Cossacks, Russia. These lots were Gharnovka, C. I. Nos. 1443 and 1447, and Yellow Gharnovka, C. I. No. 1444.

The Pererodka variety came from the Province of Orenburg, Russia.

Acme.—The Acme variety originated from a pure-line selection of Kubanka (C. I. No. 1516) made by Mr. Manley Champlin, in cooperative experiments at the Highmore Substation, Highmore, S. Dak., in 1909. This high-yielding selection was first known as No. 7 and by 1914 had been increased for sowing in plats. By 1916 it was grown commercially, and in the rust epidemic of that year it was discovered to be resistant to stem rust. As it differs from the true Kubanka it has been given the name Acme.

Arnautka.—Arnautka is probably the most widely grown durum variety in this country. The first importation of this variety was made by the United States Department of Agriculture in 1864. After being grown occasionally for a few years it was discontinued. The basis of the present commercial stock is thought to have been brought from Russia by early immigrants. Its distribution by the United States Department of Agriculture dates from 1900, when seed (C. I. No. 1494) was

[4] Accession number of the office of Foreign Seed and Plant Introduction.

obtained from Mr. T. N. Oium, of Lisbon, N. Dak. A pure-line selection (C. I. No. 4064) from this mass variety has been grown at most agricultural experiment stations and distributed somewhat. A commercial lot of seed (C. I. No. 1493), originally called "Wild Goose," obtained in North Dakota in 1901, has been grown also. This is identical with Arnautka. The Arnautka variety differs from the Kubanka chiefly in having a longer, narrower, laxer, and more tapering and more nodding spike. The variety is known in some sections under the names of local growers. One such strain, Pierson, was distributed by George H. Pierson, of Claremont, S. Dak., in 1914, and is recorded in this bulletin under that name.

Mindum.—The Mindum variety is the result of a selection made at the Minnesota Agricultural Experiment Station from a variety called Hedgerow, which was probably only a local name for Arnautka. This variety is very similar to the Arnautka, but is more resistant to stem rust.

Monad.—The Monad variety was obtained from Russia by Prof. H. L. Bolley, of the North Dakota Agricultural Experiment Station, in 1903, while making a study of the flax industry of Europe for the United States Department of Agriculture. The variety was distributed by Prof. Bolley as D–1 (Durum No. 1), but was later named Monad after it was found to be a high-yielding variety and resistant to stem rust in experiments at the Dickinson Substation, Dickinson, N. Dak. It is very similar to the Acme variety except that it has a somewhat stronger straw.

Marouani.—The Marouani variety was introduced by the Department of Agriculture from Algeria. It differs from the Arnautka and Kubanka wheats in being earlier, taller, and having longer beaks on the outer glumes.

Buford.—The Buford variety is the result of a pure-line selection made by Mr. F. R. Babcock in cooperative experiments at the Williston Substation, Williston, N. Dak., in 1909, from a variety known as Taganrog (C. I. No. 1570). The spikes of this variety are about intermediate in length and density between those of the Kubanka and Arnautka varieties.

THE RED DURUM GROUP.

Several varieties of durum wheat have red kernels, while most white or amber kerneled varieties of durum wheat contain slight mixtures of red kernels. Some selections of red-kerneled strains have been made and increased. Very few of these, however, have been grown in the experiments covered by this bulletin, and only one red-kerneled variety (D–5) is commercially grown. As this variety is not named, the group is here designated by the name of the subclass, Red Durum, in which the grain of this variety is graded under the United States official grain standards.

D–5 (Durum No. 5).—The D–5 variety was obtained from Russia by Prof. H. L. Bolley. This wheat was distributed by Prof. Bolley in 1911, and because of its rust resistance it has gained popularity and is now quite widely grown in the durum-wheat section. On the farms this wheat is often wrongly called "D–Fife" and also is known as Ladd Durum and Red Durum. The kernels of the D–5 variety are red, midsized, blunt at the brush end, and very tapering at the germ end. The glumes are white rather than yellowish, as in the varieties of the Kubanka group.

THE PELISS GROUP.

The Peliss group of durum wheat is distinguisned from the Kubanka group by black awns and very large kernels.

Peliss.—The Peliss variety was introduced by the Department of Agriculture from Oran, Algeria, where it was developed by a man named Pelissier. It was first called

Pelissier, but the name is usually mispronounced and the shorter and simpler form, Peliss, is here substituted for it. It differs from varieties of the Kubanka group in having white glumes, black awns, and very large kernels, which are somewhat curved.

Saragolla.—The Saragolla variety was introduced from Italy in 1902. It originally was a mixture of several types of durum wheat. The principal type has black awns but differs from the Peliss variety in having yellowish rather than white glumes.

MISCELLANEOUS DURUM WHEATS.

The following varieties of durum wheat can not be included in any of the preceding groups and are here listed as miscellaneous varieties:

Golden Ball.—The Golden Ball variety was introduced by the United States Department of Agriculture from South Africa in 1918. It has black awns, pubescent white glumes, and amber kernels.

Kahla.—The Kahla variety is of Algerian origin. It has black awns and glumes and amber kernels. It is grown commercially in parts of Montana, Wyoming, and the Dakotas under several names, such as Purple Durum, Black Durum, Black Emmett, and Sloat.

Velvet Don.—The Velvet Don was introduced from the Territory of the Don, Russia, in 1900. This variety has black awns, pubescent white glumes, and usually amber kernels. This introduction originally contained a considerable mixture of red-kerneled durum wheat and has sometimes been described as having red kernels.

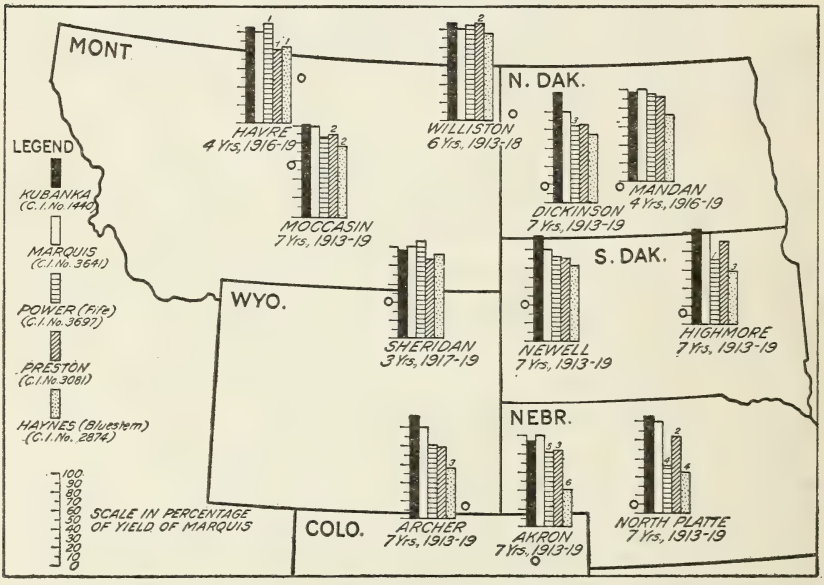


FIG. 1.—Diagram showing the location of 11 field stations in the northern half of the Great Plains area and the average yields, in percentage of the Marquis variety, of the leading commercial varieties at each station during the period of years indicated: 1, Average of only three years (Power, Preston, and Haynes at Havre and Power at Highmore); 2, average of only four years (Preston and Haynes at Moccasin, Preston at Williston and North Platte); 3, average of only six years (Power at Dickinson, Haynes at Highmore and Archer, and Preston at Akron); 4, average of only two years (Power and Haynes at North Platte); 5, yields of Glyndon Fife, C. I. No. 2873, substituted for Power Fife at Akron; 6, average of only five years (Haynes at Akron).

VARIETAL EXPERIMENTS.

This bulletin contains the results of the varietal experiments conducted on field plats at 11 experiment stations in the northern half of the Great Plains area. These investigations were conducted in order to determine the variety or varieties best adapted for growing in this semiarid section. The available material usually was grown in nursery experiments for a preliminary period and only the best varieties continued in the plat experiments. These varieties already have been discussed. The results obtained are given in Tables III to XXI and the principal data, comparing leading commercial varieties, in graphic form in figure 1. The experiment stations are widely separated and are so located that they represent fairly the larger part of the section considered.

NORTHERN HALF OF THE GREAT PLAINS AREA.

The section covered by this bulletin includes that portion of the Great Plains area extending from the Canadian boundary southward to the southern boundary of Nebraska, including portions of six States—North Dakota, South Dakota, Montana, Wyoming, Nebraska, and Colorado.

The elevation of this section varies from about 1,500 feet in the eastern portion to about 6,000 feet in the western portion, most of it lying between altitudes of 2,000 and 4,000 feet.

The climate is semiarid, the average annual precipitation varying from about 14 to 20 inches. In general, the rainfall decreases as the elevation increases to the westward across the area. The length of the frost-free period also decreases to the westward with the increase in altitude and to the northward with the increase of latitude. It varies from about 135 days in the southern portion at the lower elevations to about 90 days in the northern portion and at the highest elevations. Owing to rather high summer temperatures and fairly constant wind movement, a considerable loss of soil moisture occurs through evaporation. This increases to the southward.

In general, the soil type of this area varies from clay loam to sandy loam, with a gumbo clay soil at Newell, S. Dak.

The locations of the 11 stations, together with their altitudes above sea level, are shown in Table I. The table also gives the normal or average annual precipitation at each station and the period of years during which records are available. Finally, the prevailing soil type at each of the various stations is shown.

The annual precipitation at any one station varies more from year to year than does the average annual precipitation at different stations. That portion of the yearly rainfall occurring during the growing period for wheat (Apr. 1 to July 31) also varies widely from year to year, but, fortunately, it averages from half to two-thirds of

the total for the year throughout this section. As the amount of this seasonal rainfall has more influence on crop yields than has the amount of the annual precipitation, the wide variations in the former make wheat growing more or less hazardous. This hazard is increased by the possibility of hot winds, hail, rust, and scab, all of which occur occasionally in this area. The partial or complete failure of the spring-wheat crop in recent years in parts of this section, due to drought or plant diseases, has increased the demand for varieties whose earliness or resistance enables them to escape these ill effects.

TABLE I.—*Altitude, normal or average precipitation, and soil type at 11 stations in the northern half of the Great Plains area.*

Location of station.	Altitude.	Precipitation.		Type of soil.
		Normal or average.	Length of record.	
	Feet.	*Inches.*	*Years.*	
Williston, N. Dak.	1,875	15.07	40	Fine sandy loam.
Dickinson, N. Dak.	2,453	15.64	27	Fine sandy loam to clay loam.
Mandan, N. Dak.	1,750	17.41	[a] 44	Light sandy black loam.
Havre, Mont.	2,500	13.67	38	Dark medium clay loam.
Moccasin, Mont.	4,228	16.45	[b] 23	Dark clay loam, gravelly subsoil.
Highmore, S. Dak.	1,890	16.75	26	Glacial clay loam.
Newell, S. Dak.	2,900	14.31	12	Clay (gumbo) with shale subsoil.
Sheridan, Wyo.	3,800	14.72	23	Dark clay loam.
Archer, Wyo.	6,027	13.60	[c] 48	Medium sandy loam with some gravel.
North Platte, Nebr.	3,000	18.83	44	Loess.
Akron, Colo.	4,560	17.97	16	Sandy loam.

[a] Observations made at Bismarck, N. Dak., during part of the period.
[b] Observations made at Utica, Mont., during part of the period.
[c] Observations made at Cheyenne, Wyo.

Table II gives the annual and average precipitation at each of the 11 stations in the seven years from 1913 to 1919,[5] the period for which yields and other data are given in later tables.

TABLE II.—*Precipitation at 11 stations in the northern half of the Great Plains area in the 7-year period from 1913 to 1919, inclusive.*

Location of station.	Precipitation (inches).[a]							
	1913	1914	1915	1916	1917	1918	1919	Average.
Williston, N. Dak.	15.27	18.47	14.79	18.22	8.63	13.84	13.42	14.66
Dickinson, N. Dak.	11.93	22.74	19.77	18.21	9.23	12.36	8.35	14.66
Mandan, N. Dak.	.....	.....	.....	15.07	10.31	13.37	13.48	.....
Havre, Mont.	.....	.....	.....	19.24	11.86	8.55	7.56	.....
Moccasin, Mont.	14.96	15.67	20.68	19.87	16.87	16.38	9.90	16.33
Highmore, S. Dak.	12.46	17.52	23.35	22.02	14.80	19.46	21.32	18.70
Newell, S. Dak.	12.53	11.70	21.02	13.40	13.32	18.31	14.25	14.93
Sheridan, Wyo.	.....	.....	.....	.....	10.83	17.26	8.56	.....
Archer, Wyo.	15.88	11.77	18.32	12.38	14.26	18.87	12.33	14.83
North Platte, Nebr.	15.57	16.59	34.85	15.26	18.03	15.94	26.56	20.40
Akron, Colo.	16.55	15.58	25.00	13.74	17.50	22.28	15.52	18.02

[a] Precipitation figures obtained from the Biophysical Laboratory of the Bureau of Plant Industry, where available, otherwise from the records of the United States Weather Bureau.

[b] The normal or average precipitation at each station in the longest period for which records are available is shown in Table I.

RESULTS OF FIELD EXPERIMENTS.

The results of varietal experiments with spring wheat at 11 different experiment stations are presented here. At ten of these stations the experiments have been conducted by the Office of Cereal Investigations, either cooperatively with the State agricultural experiment station or some other agency or independently. At the remaining station the data have been obtained independently by the State agricultural experiment station. The source of the data is stated in connection with each station.

The experimental conditions, such as crop sequence, size of plat, width of alleys, and number of replications, vary somewhat at different stations. The results obtained at one station, therefore, are not necessarily comparable with those obtained at any other station. In many cases, however, they probably are directly comparable. The results from different varieties at the same station were nearly always obtained under similar conditions and may be compared directly. Any known exceptions to this fact are stated in the text. In all cases the crops were grown with only the natural rainfall and under conditions approximating good farm practice for the district. While comparative yields have been the most important results obtained, other factors have been studied. Complete agronomic notes have been recorded on the varieties at most stations. Samples of most of the varieties also have been milled and the flour baked in the milling and baking laboratory of the Bureau of Markets of the Department of Agriculture. In addition to yield, therefore, data on the following important factors are summarized: Days from emergence to maturity, height of plant, percentage of stem-rust infection, weight per bushel, percentage of crude protein, yield of flour, and volume of loaf.

YIELD PER ACRE.

The yields from the spring-wheat varieties under experiment since 1912 are shown for each station. Varieties that have been grown for only one or two years are included in the station tables but are omitted in the summary table on yields.

The annual and average yields obtained from spring-wheat varieties grown in plats at each of the 11 stations in the 7-year period [6] from 1913 to 1919, inclusive, are shown in Tables III to XIII, together with the average yields obtained in the years previous to 1913. The probable errors for each variety grown in replicated plats also are shown. Where more than one plat was grown the number of plats of each variety is stated at the top of the column for each year. Finally, in the last column, the difference between the average yield of each variety in the years grown and that of the Marquis variety in

[6] At four of the stations cereal experiments were not conducted for the entire period.

the same period is stated, the latter being grown at all stations each year. The probable error of this difference also is given. In some cases the probable error of the difference is quite large, often indicating that the differences are not significant.[7]

RESULTS AT WILLISTON, N. DAK.

The Williston Substation of the North Dakota Agricultural Experiment Station is located near Williston, N. Dak., on a fine sandy loam soil in the valley of the Missouri River at an altitude of 1,875 feet. The normal annual rainfall is 15.07 inches. The experiments at Williston have been conducted cooperatively by the North Dakota Agricultural Experiment Station and the Office of Cereal Investigations. They were started in 1908 and discontinued at the close of the 1918 crop season. The yields of spring-wheat varieties are shown in Table III.

The average acre yield of eight varieties grown during the 5-year period from 1908 to 1912, inclusive, shows the Kubanka durum wheat (C. I. No. 1440) to be the highest yielding variety at Williston, with an average yield of 24.5 bushels per acre. This yield is only slightly larger than that of the best variety of common wheat, Power Fife (C. I. No. 3697), which yielded only half a bushel less. Three strains of Bluestem wheat averaged 1.3, 2, and 3.1 bushels less than the Kubanka variety.

The Marquis wheat was included in the experiments in 1913. Since that year it has increased rapidly as a commercial variety and since 1916 has been the principal commercial variety grown in the Williston section.

In the 6-year period from 1913 to 1918, inclusive, durum varieties have continued to outyield common varieties, including the Marquis wheat. In this period the Marquis has yielded at the rate of 30.2 bushels per acre, while the Buford durum wheat, developed at the Williston Substation, produced the highest yield, averaging 34.4 bushels. The average difference of 4.3 bushels in favor of the Buford variety is significantly larger. The Kubanka (C. I. No. 1440) ranked second in yield, averaging 32.3 bushels. Power Fife also outyielded the Marquis in the 6-year period, with an average yield of 31.3 bushels per acre. In shorter periods all other durum wheats grown, as well as four common varieties, outyielded the Marquis variety. Of the common wheats, however, none have yields significantly larger than that of the Marquis. In the two years, 1917 and 1918, the three rust-resistant durum wheats, Acme, Monad, and D–5, were among the highest yielding varieties. Of these, the Monad produced the highest average yield.

[7] The relatively large size of the probable error in some cases may prove misleading. It should not, however, if it is borne in mind that the large size of this probable error is due partly to widely varying seasonal conditions in this section from year to year, causing the yields of all varieties to be very high some years and very low in other years.

TABLE III.—*Yields of 27 varieties and strains of spring wheat grown at the Williston (N. Dak.) Substation, during the 6-year period from 1913 to 1918, inclusive, with average yields in the 5-year period from 1908 to 1912, inclusive, and the average differences from the Marquis variety for the years grown.*

[Data obtained in cooperation with the North Dakota Agricultural Experiment Station.]

Class, group, and variety	C.I. No.	Yield per acre (bushels).							Average.	
		Average, 1908 to 1912.	1913 (1 plat).	1914 (2 plats).	1915 (2 plats).	1916 (2 plats).	1917 (2 plats).	1918 (2 plats).	1913 to 1918.	Difference from Marquis.
COMMON.										
Fife:										
Marquis	3641	.....	[a] 29.0	52.5±6.7	40.6±0.2	35.0±0.8	18.5±5.2	5.5±0.7	30.2	.....
Ghirka Spring	1517	[b] 29.3	22.2	40.4±3.9	42.7±1.1	37.7±0.3	19.3±5.1	.....	.....	−2.7±2.3
Ghirka Spring No. 4	4413	.....	.....	47.1±3.1	46.1±1.1	40.2±0.7	20.5±5.5	7.6±1.3	.....	+1.9±1.2
Glyndon	2873	21.5	28.2	49.2±2.1	44.1±0.6	29.0±0.8	20.3±3.7	5.7±0	29.4	− .8±1.0
Red Fife	3694	23.3	28.7	47.9±2.4	43.9±0.4	30.5±0.8	18.3±2.5	6.3±0.3	29.3	− .9±0.9
Power	3697	24.0	28.7	51.3±3.2	45.1±0.3	31.8±1.0	23.6±8.5	7.5±1.4	31.3	+1.2±1.0
Bluestem:										
Dakota	3083	23.2	30.7	47.5±0.7	44.6±1.0	28.5±0.4	20.6±2.8	7.5±0.4	29.9	− .3±1.4
Haynes	2874	21.4	30.0	42.5±0	42.9±0.2	28.4±0.8	19.9±0.2	7.5±0.7	28.5	−1.7±1.7
Do	3021	22.5	29.2	46.3±0.4	45.5±1.3	.....	.....	.....	.....	− .4±2.3
Preston:										
Pioneer	4324	.....	.....	.....	42.9±0.2	36.7±1.4	17.0±4.8	4.1±0.5	.....	+ .3±0.8
Preston	3081	.....	.....	.....	42.1±2.0	35.0±0.3	23.0±2.5	5.5±0.7	.....	+1.5±0.7
Do	3698	[a] 24.3	25.0	46.3±1.1	43.4±1.7	35.0±0.3	.....	.....	.....	−1.9±1.6
Ladoga:										
Huron	3315	.....	.....	52.2±1.1	44.2±0.2	.....	.....	.....	.....	+1.7±1.6
Manchuria	2492	.....	19.7	46.7±0	42.7±0.3	39.5±1.0	.....	.....	.....	−2.1±2.7
Miscellaneous:										
Galgalos	2398	.....	27.7	.....	.....	.....	.....	.....	.....	.....
Humpback	3690	[c] 21.0	30.0	.....	.....	.....	.....	.....	.....	.....
Prelude	4323	.....	.....	.....	30.4±0.5	29.5±1.3	14.5±6.0	4.7±0.6	.....	−5.1±1.3
Regenerated Defiance	3703	.....	.....	.....	47.7±0.3	26.0±1.7	.....	.....	.....	−1.0±6.8
World Beater	3700	.....	27.0	38.8±0.4	.....	.....	.....	.....	.....	−7.9±4.9
DURUM.										
Kubanka:										
Acme	5284	.....	.....	.....	.....	.....	22.0±1.7	7.7±0.3	.....	+2.9±0.5
Arnautka	3693	23.4	34.7	47.2±0.3	45.5±1.3	37.4±0.3	.....	.....	.....	+1.9±1.8
Do	4064	.....	.....	50.0±2.1	45.7±1.4	37.2±0.7	21.1±0.2	6.6±0.1	.....	+1.7±0.8
Buford	5295	.....	35.0	54.6±2.4	49.4±0.5	37.2±0.7	23.5±0.4	6.9±0.1	34.4	+4.3±0.9
Kubanka	1440	24.5	33.0	53.8±3.2	47.3±1.1	36.0±0.6	18.3±0.8	5.3±0.3	32.3	+2.1±0.8
Kubanka No. 8	4063	.....	.....	45.0±0.7	45.9±1.6	37.2±0.1	19.7±1.4	6.0±0.6	.....	+ .3±1.3
Monad	3320	.....	.....	.....	.....	.....	25.6±1.9	7.8±0.7	.....	+4.7±2.0
Red Durum:										
D-5	3322	.....	.....	.....	.....	.....	23.6±2.8	8.4±0.2	.....	+4.0±0.9

[a] Probable error ±0.7. [b] Average for only 4 years, 1909 to 1912. [c] Average for only 3 years, 1910 to 1912.

RESULTS AT DICKINSON, N. DAK.

The Dickinson Substation of the North Dakota Agricultural Experiment Station is located on the border of the Heart River valley, near Dickinson, N. Dak., on a soil varying from sandy loam to clay loam. The elevation is 2,453 feet, and the average annual precipitation has been 15.64 inches in a 27-year period. The varietal experiments conducted cooperatively by the North Dakota Agricultural Experiment Station and the Office of Cereal Investigations were started in 1907. The yields obtained are shown in Table IV.

TABLE IV.— *Yields of 31 varieties and strains of spring wheat grown at the Dickinson (N. Dak.) Substation during the 7-year period from 1913 to 1919, inclusive, with average yields for the 5-year period from 1907 to 1911, inclusive, and the average differences from the Marquis variety for the years grown.*[a]

Class, group, and variety	C. I. No.	Yield per acre (bushels).[b] Average 1907 to 1911.	1913 (1 plat).	1914 (4 plats).	1915 (3 plats).	1916 (3 plats).	1917 (3 plats).	1918 (3 plats).	1919 (3 plats).	Average. 1913 to 1919.	Average. Difference from Marquis.
Fife: COMMON.											
Marquis	3641	.....	24.2	14.0±0.2	32.8±0.3	13.5±1.2	17.3±0.6	14.0±1.6	3.4±0.8	17.0	.....
Ghirka Spring	1517	22.6	26.6	11.3±0.3	24.3±0.4	7.6±0.8	14.7±1.1	16.9±1.1	.....	.....	−2.4±1.3
Ghirka No. 4	4413	.....	.....	11.2±0.8	23.2±0.3	7.3±1.2	16.8±1.0	.....	.....	.....	−4.5±1.5
Ghirka No. 5	4414	.....	.....	[b] 13.2	[b] 20.0	10.0±2.2	18.2±0.6	17.6±0.9	.....	.....	−2.5±1.9
Ghirka No. 66	4425	.....	.....	[b] 12.4	[b] 20.0	8.0±1.6	17.4±0.2	.....	.....	.....	−5.0±2.0
Ghirka No. 72	4427	.....	.....	[b] 14.4	[b] 19.2	9.4±1.1	18.9±0.7	.....	.....	.....	−3.9±2.4
Glyndon	2873	.....	.....	9.3±0.5	.....	5.6±1.5	16.4±0.5	15.6±2.2	5.6±2.0	.....	−1.9±1.5
Power	3697	.....	.....	12.2±0.3	25.3±1.2	6.7±1.3	17.1±0.4	14.1±3.6	5.1±1.6	.....	−2.4±0.9
Red Fife	3329	.....	28.3	10.2±0.4	25.3±0.9	6.4±1.5	14.6±0.4	12.8±1.7	4.3±1.0	14.6	−2.5±1.1
Ruby	6047	.....	.....	.....	.....	.....	.....	.....	5.5±1.0	.....	+2.1±1.3
Rysting	3022	20.3	28.1	12.4±2.4	25.6±0.6	4.5±1.3	14.4±0.2	16.9±1.9	3.8±1.4	15.1	−1.9±1.3
Bluestem:											
Crossbred	3314	18.5	27.1	9.9±0.1	23.7±0.4	3.8±0.7	15.6±0.6	11.4±0.3	3.2±0.9	13.5	−3.5±1.2
Haynes	2874	.....	24.8	8.3±0.6	22.9±1.2	2.1±0.3	13.4±2.8	14.3±0.4	3.7±1.0	12.9	−4.1±1.3
Preston:											
Kota	5878	.....	.....	.....	.....	.....	.....	.....	6.6±1.4	.....	+3.2±1.6
Pioneer	4324	.....	.....	.....	25.2±4.4	15.0±1.1	17.6±1.1	13.9±0.2	4.7±0.5	.....	−1.1±0.6
Preston	3081	.....	25.2	12.9±0.4	24.8±0.7	8.3±0.7	16.6±0.5	11.3±0.1	2.8±0.4	14.6	−2.5±0.8
Ladoga:											
Huron	3315	.....	26.9	9.2±0.6	26.0±1.7	9.5±0.5	15.2±0.0	13.3±0.6	3.6±0.5	14.8	−2.2±0.9
Manchuria	2492	.....	18.1	[b] 8.4	[b] 28.0	.....	.....	.....	.....	.....	−5.5±0.1
Miscellaneous:											
Kubanka × Haynes	4788	.....	.....	.....	.....	.....	.....	[c] 17.4	[c] 4.3	.....	+2.2±1.1
Kubanka × Preston	4789	.....	.....	.....	.....	.....	.....	[c] 13.0	[c] 5.2	.....	+.4±0.5
Prelude	4323	.....	.....	.....	31.8±2.2	12.4±0.8	9.1±0.2	12.5±1.1	4.5±0.9	.....	−2.1±1.1
Kubanka: DURUM.											
Acme	5284	.....	.....	.....	.....	.....	18.7±0.8	17.8±0.3	6.1±0.8	.....	+2.6±0.7
Arnautka	4064	.....	30.9	11.6±0.4	44.8±2.9	14.6±1.2	16.5±1.1	16.2±0.2	5.2±1.2	20.0	+3.0±1.2
Buford	5295	.....	.....	.....	.....	.....	.....	[c] 13.2	4.3±0.7	.....	+.1±0.7
Kubanka	1440	22.4	26.7	14.2±0.3	46.8±1.4	16.9±2.3	20.1±0.4	15.7±0.3	3.9±1.3	20.6	+3.6±1.0
Kubanka No. 8	4063	.....	31.2	13.0±0.9	51.5±3.3	17.4±0.9	18.7±0.4	18.6±1.6	4.4±0.8	22.1	+5.1±1.6
Kubanka No. 98	6519	.....	.....	.....	.....	.....	.....	[c] 18.2	4.4±0.8	.....	+2.6±1.3
Mindum	5296	.....	.....	.....	.....	.....	.....	[c] 14.6	4.6±0.6	.....	+.9±0.3
Monad	3320	.....	30.9	[b] 13.6	50.1±0.9	26.2±1.3	19.9±0.9	14.6±1.7	6.4±1.2	23.1	+6.1±1.8
Red Durum:											
D-5	3322	.....	28.0	.....	.....	.....	17.8±0.9	20.2±2.1	4.5±0.6	.....	+2.9±1.0
No. 58	6518	.....	.....	.....	.....	.....	.....	[c] 16.0	4.5	.....	+1.6±0.4
Miscellaneous: Golden Ball	6227	.....	.....	.....	.....	.....	.....	.....	[b] 4.8	.....	.....

[a] Data obtained in cooperation with the North Dakota Agricultural Experiment Station. [b] The crop of 1912 was destroyed by hail. [c] Single plats only.

The acre yields for the five years, 1907 to 1911, inclusive, for four varieties grown in that period show that the Kubanka (C. I. No. 1440) averaged 22.4 bushels, outyielding two commercial strains of common wheat, Rysting Fife and Crossbred Bluestem, by 2.1 bushels and 3.4 bushels, respectively. During those years the Ghirka Spring variety (C. I. No. 1517) showed unusual promise as a drought-resistant common wheat, outyielding even the Kubanka by 0.2 bushel. The Marquis variety has been grown in 1913 and since. In the 7-year period, from 1913 to 1919, inclusive, durum varieties generally yielded more and other common varieties less than the Marquis.

In the full 7-year period, the Marquis has averaged 17 bushels per acre. Monad durum wheat has produced the highest yield, averaging 23.1 bushels, followed by Kubanka No. 8 (C. I. No. 4063) with an average yield of 22.1 bushels, and Kubanka (C. I. No. 1440) with a yield of 20.6 bushels. These yields are all significantly larger than that of the Marquis variety. During the same period the commercial common wheats, Haynes Bluestem and Preston, produced yields significantly lower than the Marquis, averaging 12.9 and 14.6 bushels, respectively. The other common wheats yielded less than the Marquis by 1.9 to 3.5 bushels.

In shorter periods the Ghirka Spring and four pure-line selections from it consistently yielded less than the Marquis and were discontinued in 1919. Among the rust-resistant varieties, the D–5 yielded on the average slightly less than the Monad in the four years the former was grown and about the same as Acme during the three years the Acme was grown, but 2.7 bushels more than Mindum in a 2-year period. Two selections from Kubanka (C. I. No. 1440), Nos. 58 and 98, also selected for rust resistance, have yielded fairly well during the last two years. Kota, a rust-resistant common wheat in the Preston group, produced the highest yield of all wheats in 1919.

RESULTS AT MANDAN, N. DAK.

The Northern Great Plains Field Station of the Office of Dry-Land Agriculture of the United States Department of Agriculture, at Mandan, N. Dak., is located near the Missouri River on upland black sandy loam soil at an altitude of 1,750 feet. The normal annual precipitation is 17.41 inches.[8] The varietal experiments with wheat, conducted cooperatively between the Office of Dry-Land Agriculture and the Office of Cereal Investigations, were started in 1916. The yields obtained during the past four years are presented in Table V.

Of the six varieties grown for four years the Marquis ranks first, with an average acre yield of 17.1 bushels. The durum varieties,

[8] Records taken at Bismarck, 6 miles distant, during part of the period.

Kubanka No. 8 and Arnautka, have averaged 16.7 bushels each, a yield slightly but not significantly less than that of the Marquis. Of the commercial common wheats the Haynes Bluestem yielded 12.5 bushels, a significant difference of 4.6 bushels less than the Marquis. The Power and Preston varieties also yielded less than Marquis by 0.8 and 1.2 bushels, respectively. The Acme was grown only in 1919 and outyielded all other varieties that year, partly, at least, because of its rust resistance.

TABLE V.—*Yields of seven varieties of spring wheat grown at the Northern Great Plains Field Station, Mandan, N. Dak., during the 4-year period from 1916 to 1919, inclusive, compared with the Marquis variety for the years grown.*

[Experiments conducted in cooperation with the office of Dry-Land Agriculture.]

Class, group, and variety.	C. I. No.	Yield per acre (bushels).					
		1916 (5 plats).	1917 (5 plats).	1918 (5 plats).	1919 (5 plats).	Average.	
						1916 to 1919.	Difference from Marquis.
COMMON.							
Fife:							
Marquis	3641	13.8±0.5	12.5±1.0	27.4±1.0	14.6±0.6	17.1	
Power	3697	9.1±0.1	16.4±0.7	26.1±1.4	14.4±0.6	16.5	−0.8±1.2
Bluestem:							
Haynes	2874	7.2±0.2	11.3±0.9	18.8±1.4	12.8±0.7	12.5	−4.6±1.5
Preston:							
Preston	3081	10.7±0.3	15.2±0.8	21.9±1.1	15.9±0.2	15.9	−1.2±1.5
DURUM.							
Kubanka:							
Acme	5284				17.2±0.6		+2.6±0.8
Arnautka	4064	12.5±0.7	15.0±0.3	27.3±1.2	12.0±0.8	16.7	−.4±0.8
Kubanka No. 8	4063	15.3±0.2	13.8±0.9	25.5±1.0	12.0±0.4	16.7	−.4±0.9

RESULTS AT HAVRE, MONT.

The Fort Assiniboine Field Station of the Montana Agricultural Experiment Station at Havre, Mont., is located on a medium clay-loam soil at an altitude of 2,500 feet and has a normal annual precipitation of 13.67 inches. Experiments with cereal varieties have been conducted at Havre for the four years, 1916 to 1919, inclusive, the Montana Agricultural Experiment Station and the Office of Cereal Investigations cooperating. The yields are shown in Table VI.

In the 4-year period the Marquis wheat has yielded at the rate of 14.6 bushels per acre. In general, durum wheat has produced larger yields than Marquis. Of the durum wheats, the Peliss has been the highest yielding variety, outyielding both Kubanka and Arnautka. It has produced an average yield of 3 bushels per acre more than Marquis. Of the common wheats, the Galgalos, a white wheat, has outyielded Marquis by 2.8 bushels. In a 3-year period, 1917 to 1919, the Power has outyielded Marquis by 0.8 bushel. All other common wheats have yielded less than Marquis, the yields of Prelude, Pioneer, and Haynes being significantly lower.

TABLE VI.—*Yields of 11 varieties of spring wheat grown at the Fort Assiniboine Field Station, Havre, Mont., during the 4-year period from 1916 to 1919, inclusive, compared with the Marquis variety for the years grown.*

[Data obtained in cooperation with the Montana Agricultural Experiment Station.]

Class, group, and variety.	C. I. No.	Yield per acre (bushels).					
		1916 (2 plats).	1917 (3 plats).	1918 (3 plats).	1919 (3 plats).	Average.	
						1916 to 1919.	Difference from Marquis.
COMMON.							
Fife:							
Marquis	3641	33.3±0	10.3±0.2	11.3±0.2	3.5±0.7	14.6	
Power	3697		10.7±0.3	12.2±0.3	4.6±0.4		+0.8±0.2
Bluestem:							
Haynes	2874		8.9±0.2	9.6±0.2	2.2±0.2		−1.5±0.1
Preston:							
Pioneer	4324			10.0±0	2.8±0.3		−1.0±0.3
Preston	3081		8.9±0.2	7.2±0.2	3.3±0.3		−1.9±0.9
Miscellaneous:							
Galgalos	2398	40.6±0.5	13.8±0.2	11.7±0	3.4±0.1	17.4	+2.8±1.3
Prelude	4323	[a] 26.6	[a] 5.0	2.9±0.3	1.4±0.3	9.0	−5.6±0.9
DURUM.							
Kubanka:							
Arnautka	4064		12.3±0.3	10.8±0.3	5.4±0.2		+1.1±0.7
Kubanka	1440	33.0±4.2	10.7±0.6	12.0±0.2	5.2±0.8	15.2	+ .6±0.3
Pererodka	1350	37.0±0.3					
Peliss:							
Peliss	1584	41.0±0.8	11.9±0.1	10.8±0.3	6.6±0.5	17.6	+3.0±1.3

[a] One plat only.

RESULTS AT MOCCASIN, MONT.

The Judith Basin Substation of the Montana Agricultural Experiment Station, Moccasin, Mont., is located on a dark clay-loam soil with a gravelly subsoil. It is at an altitude of 4,228 feet, and the average annual precipitation in 23 years was 16.45 inches.

Cereal experiments cooperative between the Montana Agricultural Experiment Station and the Office of Cereal Investigations have been conducted at Moccasin since 1908. Yields are shown in Table VII.

The average acre yields in the four years from 1908 to 1911 for eight varieties grown in that period show that durum varieties outyielded all common varieties, with the exception of Galgalos, a white wheat. This variety outyielded all others, with an average of 24.4 bushels per acre. For the 7-year period from 1913 to 1919 in which Marquis has been grown, it has yielded at the rate of 24.2 bushels per acre. Durum varieties have not consistently outyielded it. In 1913, 1915, and 1916 the Marquis outyielded all varieties of durum wheat. The Peliss variety of durum wheat has been the highest yielding variety during the entire period, yielding 0.7 bushel more than Marquis. During the same period the Kubanka (C. I. No. 1440) yielded only 0.2 bushel more than Marquis.

TABLE VII.—*Yields of 24 varieties and strains of spring wheat grown at the Judith Basin Substation, Moccasin, Mont., during the 7-year period from 1913 to 1919, inclusive, with average yields for the 4-year period from 1908 to 1911, inclusive, compared with the Marquis variety for the years grown.*

[Data obtained in cooperation with the Montana Agricultural Experiment Station.]

Class, group, and variety.	C. I. No.	Yield per acre (bushels).[a]									
		Average, 1908 to 1911.	1913 (5 plats).	1914 (5 plats).	1915 (5 plats).	1916 (5 plats).	1917 (5 plats).	1918 (5 plats).	1919 (5 plats).	Average.	
										1913 to 1919.	Difference from Marquis.
COMMON.											
Fife:											
Marquis	3641	.....	33.5	23.7±0.7	42.3±1.2	32.9±1.6	13.3±0.8	20.2±2.1	3.7±0.4	24.2	.....
Cole Hybrid	4062	.....	29.7	22.5±0.6	38.0±0.9	.....	.....	.....	.....	.....	−3.1±0.8
Early Red Fife	4932	.....	.....	.....	.....	[b] 22.9	[b] 13.3	20.0±1.4	3.8±0.3	.....	−2.5±1.8
Ghirka Spring	1517	19.0	29.0	23.0±0.7	38.0±0.7	29.0±1.1	12.8±0.9	.....	.....	.....	−2.8±0.7
Glyndon	2873	.....	20.0	22.7±0.9	41.0±0.9	26.2±1.3	11.5±0.8	.....	.....	.....	−4.9±1.8
Power	3697	.....	28.7	24.1±0.9	41.0±0.8	24.5±2.3	10.1±0.6	20.2±2.1	2.5±0.3	21.6	−2.6±0.8
Rysting	3022	18.0	26.7	23.0±1.1	40.7±1.3	25.0±1.8	10.7±0.9	22.5±1.4	3.2±0.3	21.7	−2.5±1.1
Bluestem:											
Haynes	2871	.....	.....	.....	.....	24.0±2.4	9.0±0.9	19.7±1.8	2.3±0.2	.....	−3.8±1.4
Preston:											
Fretes	1596	20.2	35.2	25.7±0.8	42.5±1.1	29.0±1.8	13.8±1.1	21.8±2.2	5.8±0.1	21.8	+0.6±0.5
Pioneer	4324	.....	.....	.....	[b] 31.6	25.2±0.9	11.7±0.7	21.5±1.3	5.6±0.2	.....	−3.4±2.0
Preston	2958	.....	29.2	22.4±0.8	41.6±1.4	.....	.....	.....	.....	.....	−2.1±0.9
Do	3081	.....	.....	.....	.....	27.1±1.4	10.8±0.7	20.0±1.4	5.6±0.2	.....	−1.7±1.2
Ladoga:											
Huron	4935	.....	.....	.....	.....	[b] 25.4	[b] 10	26.6±1.6	4.8±0.1	.....	−0.8±2.2
Miscellaneous:											
Galgalos	2398	21.4	30.7	21.5±1.1	40.5±0.3	.....	.....	.....	.....	.....	−1.3±0.8
Prelude	4323	.....	.....	.....	[b] 30.0	20.7±0.9	11.5±0.4	16.0±0.9	0.8±0	.....	−3.1±0.3
DURUM.											
Kubanka:											
Arnautka	4064	.....	.....	.....	.....	25.7±1.5	16.0±0.9	25.3±1.9	5.2±0.5	.....	+0.5±1.9
Beloturka	1520	.....	30.0	25.2±0.9	40.1±0.5	.....	.....	.....	.....	.....	−1.4±1.2
Kubanka	1440	21.1	30.7	23.0±0.7	40.7±1.6	28.7±1.7	14.3±1.2	28.0±1.4	5.7±0.5	24.4	+0.2±1.0
Kubanka No. 8	4063	.....	.....	.....	.....	28.0±1.8	13.5±1.1	.....	.....	.....	−2.4±2.2
Monad	3320	.....	.....	.....	.....	.....	[b] 14.2	24.5±1.9	6.0±0.4	.....	+2.5±0.7
Pererodka	1350	22.6	32.0	25.3±0.9	40.1±0.8	.....	.....	.....	.....	.....	−0.7±0.9
Yellow Gharnovka	1444	22.5	32.8	25.0±1.1	39.2±0.9	.....	.....	.....	.....	.....	−0.8±0.9
Peliss:											
Peliss	1584	22.5	32.0	26.5±1.3	42.2±0.9	28.7±1.6	16.2±0.6	24.5±1.7	4.2±0.1	24.8	+0.7±0.8
Red Durum:											
D–5	3322	.....	.....	.....	.....	.....	[b] 12.5	25.7±2.0	6.0±0.2	.....	+2.2±1.2

[a] The crop of 1912 was destroyed by hail.

[b] One plat only.

Among the common wheats the Fretes has been the only variety which has outyielded Marquis. The difference of 0.6 bushel is not significant, however, and as the variety has a tendency to lodge, it can not be recommended for commercial growing. The Galgalos variety was discarded after 1915 because of its weak straw and its soft white kernel. The Power Fife has an average yield of 21.6 bushels, or a significant difference of 2.6 bushels per acre less than Marquis, in the seven years. The average yield of Rysting Fife has been nearly identical with that of Power Fife. All other common wheats grown in shorter periods of years have on the average yielded less than Marquis.

During the three years from 1917 to 1919 the Monad durum wheat has outyielded Marquis by a significant difference of 2.5 bushels per acre, but its yields have not been greater than those of Peliss in the same period. Other durum wheats which are being continued in the experiment have yielded somewhat more than the Marquis variety in the periods grown.

RESULTS AT HIGHMORE, S. DAK.

The Highmore Substation of the South Dakota Agricultural Experiment Station is located near Highmore, S. Dak., on a glacial clay-loam soil at an altitude of 1,890 feet. The average annual rainfall has been 16.75 inches during the last 26 years. The cereal experiments have been conducted by the South Dakota Agricultural Experiment Station in cooperation with the Office of Cereal Investigations since 1902. The more recent yields obtained are shown in Table VIII.

From 1905 to 1912 nine varieties of wheat were grown continuously. In that 8-year period three strains of Kubanka durum wheat significantly outyielded all varieties of common wheat. Among the common wheats the Haynes (C. I. No. 2874) produced the highest average yield. During the 7-year period from 1913 to 1919, inclusive, the Marquis has been the highest yielding common wheat, producing an average of 15.5 bushels per acre. During the same period the Kubanka durum (C. I. No. 1440) has yielded at the rate of 15.8 bushels or only 0.3 bushel per acre more and the Preston (C. I. No. 3081) 14.1 bushels or 1.4 bushels less than the Marquis. The Marquis has significantly outyielded the Haynes variety, exceeding it in yield in each of the seven years. It also has outyielded all other varieties of common wheat and all but five of the durum varieties. In the 6-year period from 1914 to 1919, inclusive, the Acme has been the highest yielding wheat. During that period it significantly outyielded Marquis by 6.2 bushels per acre. Because of these excellent yields and the discovery of its rust resistance in 1916, the Acme has been increased and distributed commercially in many sections of South Dakota. About 5,000 acres were grown in 1919. In the three

years from 1917 to 1919, inclusive, it has exceeded the average yield of Monad by 0.3 and that of D–5 by 0.1 bushel. Other durum wheats which are not so resistant to stem rust have not yielded as well as these three varieties.

TABLE VIII.—*Yields of 42 varieties and strains of spring wheat grown at the Highmore (S. Dak.) Substation during the 7-year period from 1913 to 1919, inclusive, with average yields in the 8-year period from 1905 to 1912, inclusive, and the average differences from the Marquis variety for the years grown.*

[Data obtained in cooperation with the South Dakota Agricultural Experiment Station.]

Class, group, and variety.	Yield per acre (bushels).										
	C. I. No.	Average, 1905 to 1912.	1913	1914	1915	1916 (2 plats).	1917 (2 plats).	1918 (2 plats).	1919	Average. 1913 to 1919.	Average. Difference from Marquis.
COMMON.											
Fife:											
Marquis	3641	.....	12.7	13.3	33.3	6.4±0.6	11.4±1.2	20.9±0.4	10.3	15.5	.....
Ghirka	1517	11.1	6.5	11.3	16.7	7.2±0.4	9.1±6	.....	.....	.....	−5.2±2.1
Glyndon	2873	.....	8.7	7.3	10.0	.....	9.5±0.3	.....	.....	.....	−8.3±2.5
Power	2989	10.5	6.3	8.7	26.7	.....	.....	.....	.....	.....	−5.9±0.5
Do	3025	.....	4.8	6.7	15.0	.....	.....	.....	.....	.....	−11.0±3.0
Do	3697	.....	.....	.....	.....	5.0±0	10.8±0.3	16.7±3.5	2.2	.....	−3.6±1.2
Bluestem:											
Dakota	3083	12.7	1.0	2.0	18.3	.....	.....	.....	.....	.....	−12.7±0.9
Haynes	1505	12.2	7.7	4.8	22.5	.....	.....	.....	.....	.....	−8.1±1.2
Do	2874	12.9	.....	7.5	18.3	1.7±0	9.7±0	18.4±1.4	1.1	.....	−6.4±1.4
Preston:											
Erivan	2397	.....	9.7	15.0	11.7	.....	.....	.....	.....	.....	−7.7±5.6
Kara	3078	.....	8.7	7.5	3.3	.....	.....	.....	.....	.....	−13.3±6.7
Do	3269	.....	.....	7.1	2.0	.....	.....	.....	.....	.....	−18.7±5.0
Pioneer	4324	.....	.....	.....	26.7	6.7±0.7	7.5±1.0	18.3±4.9	10.3	.....	−2.6±0.9
Preston	3081	12.6	6.5	12.0	35.8	7.0±0.5	9.7±0.9	20.0±0.7	7.8	14.1	−1.4±0.6
Do	2958	.....	12.5	.....	.....	.....	.....	.....	.....	.....	−.2
Ladoga:											
Manchuria	2492	.....	5.3	16.8	36.7	.....	.....	.....	.....	.....	−.2±2.9
Miscellaneous:											
Ak	3076	.....	8.3	6.4	3.3	.....	.....	.....	.....	.....	−13.8±6.5
Bugdai	3079	.....	6.7	9.5	.....	.....	.....	.....	.....	.....	−4.9±0.9
Prelude	4323	.....	.....	.....	25.0	9.5±0.5	6.4±0.5	12.1±2.4	14.8	.....	−2.9±2.3
Wisconsin Wonder	5525	.....	.....	.....	.....	.....	.....	.....	14.8	.....	.....
DURUM.											
Kubanka:											
Acme	5284	.....	.....	30.0	31.7	22.0±1.3	12.7±1.7	18.4±1.4	17.5	.....	+6.2±2.0
Algeria	3310	.....	.....	.....	.....	17.0±0.5	12.1±0	13.7±1.8	12.5	.....	+1.5±2.4
Arnautka	1547	.....	2.8	.....	.....	.....	.....	.....	.....	.....	−9.9
Do	4064	.....	.....	.....	38.3	7.5±0.7	1.3±0.1	16.7±1.4	2.5	.....	−3.2±2.0
Buford	5295	.....	.....	.....	.....	.....	.....	.....	11.1	.....	+1.8
Kubanka	1354	17.5	3.3	22.2	30.0	.....	.....	.....	.....	.....	−1.3±4.0
Do	1440	15.9	2.0	19.7	33.3	12.2±0.4	15.2±1.7	12.9±0.3	15.5	15.8	+.3±1.9
Do	1516	17.8	4.2	.....	.....	.....	.....	.....	.....	.....	−8.5
Do	2094	.....	1.5	.....	.....	.....	.....	.....	.....	.....	−11.2
Do	2246	.....	2.3	.....	.....	.....	.....	.....	.....	.....	−10.4
Do	3303	.....	.....	.....	28.3	.....	.....	.....	.....	.....	−5.0
Kubanka No. 8	4063	.....	.....	.....	11.0	10.5±0.5	13.3±1.2	.....	.....	.....	−5.4±6.7
Mindum	5296	.....	.....	.....	.....	.....	.....	.....	8.6	.....	−1.7
Monad	3320	.....	.....	.....	.....	.....	17.3±1.2	14.6±3.2	15.8	.....	+1.7±3.2
Pierson	4163	.....	.....	.....	40.0	10.0±0.7	1.3±0.1	21.3±1.7	3.9	.....	−1.2±2.3
White Turkish	3290	.....	2.2	7.0	.....	.....	.....	.....	.....	.....	−8.4±1.8
Red Durum:											
D–5	3322	.....	.....	.....	.....	.....	19.3±1.2	12.5±2.1	16.4	.....	+1.9±4.1
Gharnovka selection	1444	.....	3.3	29.3	33.3	10.0±0.7	1.1±0.3	20.0±1.4	.....	.....	−.1±2.5
Miscellaneous:											
Golden Ball	6227	.....	.....	.....	.....	.....	.....	.....	11.4	.....	+1.1
Kahla	6252	.....	.....	.....	.....	.....	.....	.....	10.5	.....	+.2
Do	6046	.....	.....	.....	.....	.....	.....	14.0±3.2	7.5	.....	−4.8±1.

RESULTS AT NEWELL, S. DAK.

The Belle Fourche Experiment Farm of the Office of Western Irrigation Agriculture is located at an altitude of 2,900 feet on the Belle Fourche Reclamation Project, near the town of Newell, 25 miles northeast of the Black Hills. The soil is a heavy clay or gumbo, classed as Pierre clay, with a shale subsoil. The average annual rainfall for the past 12 years is 14.31 inches. Cereal experiments have been conducted since 1908 in cooperation with the Office of Western Irrigation Agriculture and since 1912 under cooperative agreement with the South Dakota Agricultural Experiment Station. The experiments reported here were conducted wholly under dry-land farming methods. The climate is not materially influenced by the proximity of the Black Hills, so that drought, hot winds, and severe winter temperature are important factors in limiting crop production. The more important yields are shown in Table IX.

Five varieties of durum wheat and five varieties of common wheat were grown during the 5-year period from 1908 to 1912, inclusive. The durum varieties were consistently the better yielders, Kubanka (C. I. No. 1440) leading with an average yield of 10.7 bushels per acre. During the seven years from 1913 to 1919, durum varieties have continued to outyield common varieties, including even the Marquis, which has yielded at the rate of 18.3 bushels per acre. The Kubanka (C. I. No. 1516) has produced the highest average acre yield, 22.6 bushels, outyielding Marquis by a significant difference of 4.3 bushels. All other durum varieties also have outyielded Marquis, and ten of them by differences that are significant. Of the common wheats, Changli, a soft Chinese wheat, outyielded Marquis by 0.2 bushel in a 5-year period, but was discarded because of poor milling quality. The Kitchener has outyielded Marquis during the two years, 1918 and 1919, and the Laramie and Norka outyielded Marquis in 1919. All other common wheats have been outyielded by Marquis. Of the rust-resistant durum wheats grown during the past three years the Acme has outyielded Monad and D–5 by 0.3 and 0.8 bushel, respectively. In the same period Kubanka selection No. 712 has outyielded Acme by 0.4 bushel.

TABLE IX.—*Yields of 36 varieties and strains of spring wheat at the Belle Fourche Experiment Farm, Newell, S. Dak., during the seven years from 1913 to 1919, inclusive, with average yields for the 5-year period from 1908 to 1912, inclusive, and the average differences from the Marquis variety for the years grown.*

[Data obtained in cooperation with the Office of Western Irrigation Agriculture and, since 1912, with the South Dakota Agricultural Experiment Station.]

Class, group, and variety.	C. I. No.	Yield per acre (bushels).									
		Average, 1908 to 1912.	1913 (2 plats).	1914 (5 plats).	1915 (3 plats).	1916 (3 plats).	1917 (3 plats).	1918 (3 plats).	1919 (2 plats).	Average.	
										1913 to 1919.	Difference from Marquis.
COMMON.											
Fife:											
Marquis	a3644	.....	16.8±0.8	8.0±0.4	50.9±0.5	8.1±0.2	8.3±0.3	29.3±2.4	6.7±1.1	18.3	.....
Ghirka Spring	1517	8.5	16.3±0.2	.....	40.2±2.6	8.9±0.2	11.1±0.5	.....	.....	.....	−1.9±1.9
Glyndon	2873	.....	15.8±0.8	6.3±0.6	39.8±0.7	4.1±0.3	9.1±0.3	.....	.....	.....	−3.4±1.4
Kitchener	c4800	.....	.....	.....	.....	.....	.....	b30.9	8.5±0.6	.....	+1.7±0.1
Power	3697	9.3	16.6±0.6	5.1±0.5	43.4±1.2	6.5±0.4	10.2±0.3	30.0±2.9	6.3±1.7	16.9	−1.4±0.8
Ruby	6047	.....	.....	.....	.....	.....	.....	.....	6.9±0.2	.....	.....
Rysting	3022	8.9	15.0±0.4	5.1±0.2	40.6±0.7	4.4±0.4	8.8±0.2	.....	.....	.....	−3.6±1.1
Bluestem:											
Haynes	2874	.....	14.2±0.1	4.7±0.4	42.0±0.5	5.6±0.4	8.0±0.5	26.9±1.3	d5.0±0.6	15.2	−3.1±0.6
Do	3020	8.2	14.1±0.3	5.1±0.4	.....	.....	.....	.....	.....	.....	−2.8±0.1
Preston:											
Pioneer	4324	.....	.....	.....	b45.4	6.2±1.5	9.2±0.4	24.0±2.3	5.2±0.2	.....	−2.7±0.9
Preston	3084	.....	19.5±0.3	7.2±0.6	46.9±1.2	5.8±0.4	8.5±0.4	22.7±2.4	5.3±1.2	16.6	−1.7±0.8
Do	3087	.....	19.0±0.1	6.6±0.4	47.2±1.7	.....	.....	.....	.....	.....	−1.0±1.3
Ladoga:											
Changli	2944	.....	14.6±0.3	12.2±0.5	43.8±1.4	8.0±2.0	14.4±1.2	.....	.....	.....	−0.2±1.7
Huron	4935	.....	.....	.....	.....	5.2±0.5	6.6±0.6	32.7±3.2	5.0±0.7	.....	−0.7±1.0
Ladoga	4151	.....	16.2±0.2	7.9±0.5	32.8±1.3	.....	.....	.....	.....	.....	−6.3±4.7
Laramie	6235	.....	.....	.....	.....	.....	.....	.....	7.7±1.2	.....	.....
Manchuria	c2492	9.9	17.1±0.5	7.8±0.2	45.6±1.2	12.9±1.0	12.2±0.2	24.2±1.6	6.9±0.5	18.1	−0.2±1.0
Norka	4377	.....	.....	.....	.....	.....	.....	.....	7.5±0	.....	.....
Miscellaneous:											
Prelude	4323	.....	.....	.....	b35.4	8.1±1.7	12.6±0.4	27.7±3.2	3.1±0.6	.....	−3.3±2.1
Regenerated Defiance	3703	.....	.....	6.6±0.3	.....	.....	.....	.....	.....	.....	.....
DURUM.											
Kubanka:											
Acme	5284	.....	.....	.....	.....	.....	10.9±0.1	35.3±1.0	9.7±0.4	.....	+3.9±0.9
Arnautka	1493	10.6	17.1±0.3	9.5±0.4	54.9±1.8	14.8±0.4	11.0±0.4	34.0±1.7	9.4±0.6	21.5	+3.2±0.6
Do	4064	.....	.....	.....	56.2±2.4	10.3±0.8	13.1±0.4	34.2±1.9	9.9±0.6	.....	+4.1±0.3

Buford	5295								8.3±0.8		
Kubanka	1440	10.7	15.6±0.3		54.4±3.4	13.8±0.7	11.3±0.2	34.5±2.1	8.7±0.8		+3.0±0.6
Do	1516	10.3	19.1±0.5	9.6±0.5	54.5±1.1	19.7±0.7	11.8±0.5	34.9±2.3	8.9±0.8	22.6	+4.3±0.8
Kubanka No. 8	4063					11.0±0.8	6.6±1.0				+0.6±1.9
Kubanka Sel. No. 712	1516						[b]12.5	35.8±2.0	8.6±1.2		+4.2±0.9
Kubanka Sel. No. 715	1516						[b]12.5	33.5±2.5	9.0±0.5		+3.6±0.5
Mindum	5296								9.0±0.6		
Monad	3320						11.6±0.1	33.6±1.7	9.7±0.6		+3.5±0.3
Pererodka	1350	10.2	16.7±0.6	9.8±1.0	58.2±1.4	13.7±0.4					+3.7±1.4
Pierson	4163							36.3±1.9	[b]6.3		+3.3±3.1
Yellow Gharnovka	1444	9.7	16.5±0.4	7.4±0.3	54.0±1.6						+0.7±0.9
Red Durum:											
D-5	3322						11.8±0.1	32.9±1.2	8.6±0.3		+3.0±0.4
Selection No. 735	1516						[b]10.4	35.3±0.9	8.6±0.5		+3.3±1.0

[a] Marquis, C. I. No. 3276, grown 1912 to 1916, inclusive.
[b] One plat only.
[c] Power, C. I. No. 3025, grown 1908 to 1916, inclusive.
[d] Three plats.
[e] Manchuria, Selection No. 2492-38, grown in 1918 and 1919.

RESULTS AT SHERIDAN, WYO.

The Sheridan Field Station is located in northern Wyoming at an altitude of 3,800 feet on dark clay-loam soil. The average annual precipitation during the past 23 years was 14.72 inches. The cereal experiments were started in 1917 and have been conducted in cooperation with the Office of Dry-Land Agriculture. Owing to an extreme drought in the season of 1919 the spring-wheat crop was an almost complete failure. The annual and average yields of the spring-wheat varieties are shown in Table X.

The experiments have been conducted only three years, in one of which there was crop failure, so that definite conclusions can not be drawn from the present results. There is very little difference between the average yields of the common and durum wheats. The Marquis variety has produced an average yield of 12.6 bushels per acre. The Peliss, with 13.1 bushels per acre, has the highest average yield of the durum varieties and is the only one that has outyielded Marquis. Three varieties of common wheat have outyielded Marquis, but none of them by a significant quantity.

TABLE X.—*Yields of 12 varieties of spring wheat grown at the Sheridan (Wyo.) Field Station during the 3-year period from 1917 to 1919, inclusive, compared with the Marquis variety for the years grown.*

[Data obtained in cooperation with the Office of Dry-Land Agriculture.]

Class, group, and variety.	C. I. No.	Yield per acre (bushels).				
		1917 (3 plats).	1918 (3 plats).	1919 (3 plats).	Average.	
					1917 to 1919.	Difference from Marquis.
COMMON.						
Fife:						
Marquis	3641	6.7±1.8	31.1±1.1	0	12.6	.....
Ghirka Spring	1517	9.3±1.6	29.6±3.0	.1	13.0	+0.4±0.9
Glyndon	2873	7.3±3.0	26.1±2.0	.1	11.2	−1.4±1.4
Power	3697	10.0±0.8	30.3±1.3	.1	13.5	+ .9±1.0
Bluestem:						
Haynes	2874	7.0±4.4	27.5±1.2	0	11.5	−1.1±1.0
Preston:						
Pioneer	4324	10.7±1.8	29.7±2.5	.2	13.5	+ .9±1.2
Preston	3081	9.3±1.6	23.6±1.3	.1	11.0	−1.6±2.4
Miscellaneous:						
Prelude	4323	12.3±2.2	22.6± .9	0	11.6	−1.0±3.0
DURUM.						
Kubanka:						
Arnautka	4064	10.0±1.6	20.4±1.0	0	10.1	−2.5±3.3
Kubanka	1440	8.6±2.4	27.5±3.7	.2	12.1	− .5±1.2
Kubanka No. 8	4063	8.7±2.2	25.1±1.8	.1	11.3	−1.9±1.6
Peliss:						
Peliss	1584	12.7±2.0	26.6±2.3	.1	13.1	+ .5±2.0

RESULTS AT ARCHER, WYO.

The Cheyenne Field Station at Archer, Wyo., is located on a fairly sandy loam containing some gravel. The altitude is almost exactly 6,000 feet above sea level. The normal rainfall is only 13.60 inches.

TABLE XI.—*Yields of 47 varieties and strains of spring wheat grown at the Cheyenne Field Station, Archer, Wyo., during the 7-year period from 1913 to 1919, inclusive, compared with the Marquis variety for the years grown.*

[Data obtained in cooperation with the Wyoming State Board of Farm Commissioners.]

Class, group, and variety	C. I. No.	Yield per acre (bushels).							Average.	
		1913	1914	1915 (2 plats).	1916 (4 plats).	1917 (4 plats).	1918 (4 plats).	1919 (4 plats).	1913 to 1919.	Difference from Marquis.
COMMON.										
Fife:										
Marquis	3641	9.0	8.4±0.1	20.9±0.3	5.4±0.4	16.6±0.7	36.9±1.6	1.3±0.3	14.1	
Cole Hybrid	4062	8.5	10.4	19.7±0.5						+0.1±0.8
Ghirka Spring	1517	9.2	10.0±0.5	13.2±1.0	5.6±0.4	16.2±1.4	28.3±0.3	1.0±0.2	11.9	−2.2±1.2
Glyndon	2873	5.8	9.6	12.5±1.0	5.7±0.4	15.1±0.6	30.4±1.3	.6±0.2	11.4	−2.7±1.0
Power	3697	4.7	7.3	12.3±1.1	5.7±0.5	16.3±1.1	31.9±1.8	1.1±0.5	11.3	−2.8±0.9
Rysting	3022	8.3	8.1	11.7±0.5	5.6±0.4	16.3±1.1	32.0±1.4	.6±0.1	11.8	−2.3±0.9
Kitchener	4800						36.7±4.2	2.8±0.6		+.7±0.7
Ruby	6047						26.3	1.3±0.2		−5.3±4.5
Bluestem:										
Crossbred	3695	1.3	3.1	9.0±0.5						−8.3±1.4
Haynes	2874	4.4	9.0±0.1	11.7±0.3	5.0±0.4		15.5±0.8	.8±0.2		−5.9±2.4
Do	3021	2.6	5.3	10.7±1.1						−6.6±1.5
Marvel	3082	3.4	6.5	11.2±0.4						−5.8±1.6
Preston:										
Converse	4141	8.3	10.2	19.0±0.8	5.9±0.2	17.5±0.6	32.8±1.0	2.4±0.2	13.7	−.4±0.6
Erivan	2397	9.4	9.5	22.0±0.8	7.5±0.2	17.9±0.7	43.7±2.4	5.2±0.5	16.5	+2.4±0.6
Preston	3081	4.7	8.1	14.8±1.4	2.1±0.4	14.0±0.3	31.7±1.4	2.8±0.6	11.2	−2.9±0.7
Do	3698	6.7	9.8	15.3±0.6						−2.2±1.4
Do	4153				3.2±0.1	16.8±1.0				−1.0±1.0
Pioneer	4324				7.7±0.6	18.2±0.8	28.9±0.9	1.8±0.4		−.9±1.7
Ladoga:										
Ladoga	4154	8.7	8.5	19.5±0.1						−.6±0.4
Norka	4377	7.2	9.3	19.3±1.1	7.2±0.4	20.8±0.5	37.8±1.2	4.2±0.5	15.1	+1.0±0.6
Huron	4935				6.6±1.0	16.0±0.6	36.3±2.5	2.2±0.1		+.2±0.4
Laramie	6233						36.3±1.5	1.7±0.1		−.1±0.4
Miscellaneous:										
Galgalos	2398	7.9	10.3±0.4	21.2±1.8	6.1±0.4	18.1±1.3	40.2±1.3	3.9±0.3	15.4	+1.3±0.4
Regenerated Defiance	3703	7.7	9.3	9.5±0.4						−4.0±3.0
Prelude	4323				5.0±0.2	12.4±0.4	22.2±2.1	1.6±0.1		−4.8±2.4
DURUM.										
Kubanka:										
Acme	5284					16.2±1.0	37.3±1.7	7.3±1.4		+2.0±1.6
Arnautka	1493	7.2	12.3	23.8±0.7	6.1±0.3	18.5±0.3	34.3±1.1	5.3±0.8	15.4	+1.3±0.7
Do	4064	6.4	10.7+0.6	23.6±2.8	6.9±0.5	18.9±0.5	32.3±0.9	4.3±0.2	14.7	+.6±0.9
Beloturka	1520	7.7	11.9	28.9±0.3	5.1±0.5	17.0±0.3	38.5±0.9	4.0±0.5	16.2	+2.1±0.8
Kubanka	1354	7.7	12.8	22.1±1.6						+1.4±1.2
Do	1440	7.5	12.5	25.6±0.8	5.8±0.2	20.9±1.2	32.9±1.9	5.3±0.5	15.8	+1.7±1.0
Do	1516	7.1	13.0	27.6±1.1	6.5±0.3	20.0±1.6	35.1±0.4	5.6±0.5	16.4	+2.3±1.0
Kubanka No. 8	4063				6.4±0.5	20.8±0.6	36.5±0.5	4.8±0.4		+2.0±0.9
Gharnovka	1447	7.5	12.3	24.1±1.6						+1.8±1.4
Marouani	1593	7.9	11.5±0.8	21.5±1.3	7.6±0.6	18.2±1.2	33.6±0.6	5.2±0.1	15.1	+1.0±0.7
Monad	3320					17.4±1.0	34.1±1.3	6.3±0.8		+1.0±1.6
Pererodka	1350	8.3	12.8	26.0±0.8	5.4±0.5	18.9±1.2	36.5±1.1			+1.8±0.7
Yellow Gharnovka	1444	7.8	11.5	25.9±1.4						+2.3±1.4
Buford	5295							5.7±0.3		
Mindum	5296							4.0±0.8		
Red Durum:										
D-5	3322					16.1±0.7	33.8±2.8	4.5±0.6		−.2±1.3
Peliss:										
Peliss	1584	8.7	11.6±0.3	22.6±2.0	5.9±0.5	18.0±0.6	34.3±1.9	6.3±1.0	15.3	+1.2±0.5
Saragolla	2228	6.7	10.3	18.8±2.1						−.9±1.1
Miscellaneous:										
Bledur	1471	7.3	11.8	13.1±4.1						−2.1±2.3
Kahla	3024	7.5	10.5±0.4	22.8±4.0						+.8±0.9
Velvet Don	1445	8.6	10.8	24.4±2.6						+1.8±0.9
Golden Ball	6227							5.5±1.0		

The rainfall records are mostly from Fort D. A. Russell at Cheyenne, 9 miles distant, where conditions probably are slightly more favorable

than at Archer. The conditions of high altitude and northern latitude allow only a short growing season, and this combined with the low rainfall makes crop growing somewhat difficult. The experiments were started in 1913 and are conducted by the Office of Cereal Investigations in cooperation with the Wyoming State Board of Farm Commissioners. In 1919 a change in the State law made the director of the Wyoming Agricultural Experiment Station the chairman of this board. The annual and average yields of the spring-wheat varieties are given in Table XI.

During the 7-year period from 1913 to 1919, inclusive, durum wheat generally has outyielded common wheat, including the Marquis variety. The latter has yielded at the rate of 14.1 bushels per acre. It has outyielded the Power and Preston varieties and most of the Bluestem strains by significant quantities. It has been outyielded, however, by five varieties of common wheat. The Erivan and Galgalos have exceeded it in yield by the significant differences of 2.4 and 1.3 bushels per acre, respectively. These wheats have weak straw and for that reason have not been distributed commercially. The Norka variety has also outyielded Marquis by 1 bushel, Kitchener has outyielded it by 0.7 bushel, and Huron by 0.2 bushel per acre. These differences, however, are not significant. All of the durum wheats continued in the experiments except D–5 have outyielded Marquis. During the 7-year period the highest-yielding durum wheat was Kubanka (C. I. No. 1516), averaging 16.4 bushels per acre, followed closely in yield by Beloturka and Kubanka (C. I. No. 1440). The Peliss variety also has yielded fairly well, averaging 15.3 bushels per acre. In the 3-year period from 1917 to 1919, inclusive, the Acme has given about the best results, outyielding the other rust-resistant durum varieties, Monad and D–5, by 1 and 2.2 bushels, respectively.

RESULTS AT NORTH PLATTE, NEBR.

The North Platte substation of the Nebraska Agricultural Experiment Station is located in the valley of the South Platte River, just above the junction of the North and South Forks, near the town of North Platte. It lies at an altitude of 3,000 feet and is located on a porous clay-loam soil known as loess. The normal annual precipitation is 18.83 inches. Varietal experiments with spring wheat have been conducted at the North Platte substation by the Nebraska station for a number of years. Since 1915 Mr. L. L. Zook, of the Office of Dry-Land Agriculture, has had supervision of the experiments. The results since 1913 which are reported here have been furnished by Mr. Zook through the courtesy of the Nebraska Agricultural Experiment Station. The yields are shown in Table XII.

TABLE XII.—*Yields of 25 varieties and strains of spring wheat grown at the North Platte (Nebr.) Substation during the 7-year period from 1913 to 1919, inclusive, compared with the Marquis variety for the years grown.*

[Data used by courtesy of the Nebraska Agricultural Experiment Station.]

Class, group, and variety.	C. I. No.	Yield per acre (bushels).								
		1913	1914	1915	1916	1917	1918	1919	Average.	
									1913 to 1919	Difference from Marquis.
COMMON.										
Fife:										
Marquis	3641	6.8	4.3	20.2	18.3	8.8	10.5	14.0	11.8	
Ghirka Spring	1517				16.3	9.5	9.5	10.4		−1.5±0.7
Glyndon	2873				11.7					
Kitchener	4800							6.5		
Power	3697				10.8	3.4				−6.4±0.9
Bluestem:										
Haynes	2874				10.3	1.8				−7.5±0.4
Preston:										
Humpback II	6049						9.6	9.1		−2.9±1.7
Pioneer	4324				19.7	5.4	10.6	7.5		−2.1±1.4
Preston	3081				15.8	9.7	10.5	7.1		−2.1±1.3
Preston (Scotch Fife)	4797	3.0	3.0	6.6	15.9	11.5				−3.7±1.7
Red Spring (Potter)	4799	4.9	2.8	6.6	17.9	13.4	9.4			−2.5±1.4
Ladoga:										
Laramie	6235							7.2		
Miscellaneous:										
Defiance		3.9	3.1	3.0						−7.1±4.0
Galgalos			2.2	2.8						−9.8±6.5
Prelude	4323				20.2	21.8	9.0	10.8		+2.6±2.6
White Palisade	4798	8.3	4.1	20.2	18.7	13.4	10.2	14.6	12.8	+.9±0.4
DURUM.										
Kubanka:										
Acme	5284							14.4		
Arnautka	4064				17.8	10.6	8.4	14.0		−.2±0.5
Gharnovka		7.2	3.0	24.1	20.0	9.8	9.4			+.8±0.5
Kubanka	1440	7.3	2.1	21.0	18.4	13.5	8.9	15.8	12.4	+.6±0.5
Kubanka No. 8	4063				19.0	6.2	9.1	13.1		−1.1±0.5
Kubanka selection No. 1		7.7	3.9	17.1	19.5	8.1	8.6			−.7±0.5
Miscellaneous:										
Kahla		9.8	2.9	19.2	18.4	11.1	9.0			+.3±0.6
Saragolla		9.0	2.7	13.6	18.7	11.6	9.4			−.7±0.9
Velvet Don		8.9	4.0							+.9±1.0

In the 7-year period from 1913 to 1919, inclusive, Marquis wheat has yielded at the rate of 11.8 bushels per acre. During the same period a white wheat known as Palisade has outyielded it by 0.9 and Kubanka durum wheat by 0.6 bushel, respectively. In shorter periods four other durum wheats and Prelude common wheat have outyielded the Marquis, but none of them by a difference that is significant. The earliness of the Prelude variety has given it an advantage over other varieties in two of the four years during which it has been grown. The late-maturing varieties, such as Haynes Bluestem, are usually at a greater disadvantage in this section than farther north, as they generally are damaged or destroyed by hot winds, summer droughts, or rust. The Humpback II variety, which is grown commercially in the vicinity, has not yielded as well as the Marquis in the two years 1918 and 1919. All varieties of spring wheat have produced low yields at North Platte, as this district is much better adapted to growing hard winter wheat.

TABLE XIII.—*Yields of 32 varieties and strains of spring wheat grown at the Akron (Colo.) Field Station during the 7-year period from 1913 to 1919, inclusive, with average yields for the 5-year period from 1908 to 1912, inclusive, and the average differences from the Marquis variety for the years grown.*

[Data obtained in cooperation with the Office of Dry-Land Agriculture.]

Class, group, and variety.	C. I. No.	Yield per acre (bushels).									
		Average, 1908 to 1912.	1913	1914 (2 plats).	1915 (2 plats).	1916 (3 plats).	1917 (4 plats).	1918 (4 plats).	1919 (4 plats).	Average.	
										1913 to 1919.	Difference from Marquis.
COMMON.											
Fife:											
Marquis	3641	.....	7.5	19.7±0.3	29.6±0.4	11.8±0.5	7.3±2.1	3.7±0.7	8.5±2.0	12.6	.....
Cole Hybrid	4062	18.4	8.0	[a] 21.0	.....	.....	.....	.....	.....	.....	+0.9±0.3
Ghirka Spring	1517	18.6	11.7±2.0	19.3±0.3	24.2±0.5	7.5±0.6	8.2±1.9	4.1±0.9	7.5±2.3	11.8	−.8±0.8
Glyndon	2873	14.6	8.0	[a] 16.6	27.7±1.0	7.2±0.7	6.6±1.7	2.5±0.9	4.3±1.4	10.4	−2.2±0.5
Power	3697	.....	.....	.....	.....	1.6±0	.....	1.2±0.5	4.7±1.7	.....	−5.5±1.9
Bluestem:											
Haynes	2874	.....	.....	.....	16.4±0.5	.8±0	4.9±1.4	1.0±1.2	2.7±0.9	.....	−7.0±1.7
Preston:											
Converse	4141	16.9	8.3	[a] 23.0	23.9±1.0	7.7±1.1	7.0±1.6	7.5±2.4	11.1±1.1	12.6	0
Erivan	2897	18.6	12.0	[a] 19.3	19.5±1.0	7.8±0.9	9.2±1.6	10.5±2.0	12.9±0.7	13.0	+.4±1.6
Pioneer	4324	.....	.....	.....	[a] 28.7	6.9±0.4	8.1±1.8	9.1±2.1	13.9±0.4	.....	+1.1±1.4
Preston	3081	.....	.....	[a] 18.3	26.2±0.3	7.2±1.0	6.9±2.0	2.5±0.4	5.9±2.2	.....	−2.2±0.5
Ladoga:											
Laramie	6235	.....	.....	.....	.....	.....	.....	.....	5.6±1.9	.....	−2.9
Manchuria	2492	.....	.....	.....	21.2±2.9	.....	.....	.....	.....	.....	−8.4
Norka	4377	17.2	8.6	[a] 16.3	.....	.....	.....	.....	.....	.....	−1.2±2.3
Miscellaneous:											
Galgalos	2398	20.4	14.1±1.8	21.7±1.4	24.4±4.9	10.5±0.5	9.2±2.2	10.7±1.9	5.8±0.2	13.8	+1.2±1.2
Prelude	4323	.....	.....	.....	[a] 29.5	8.3±1.0	6.0±1.2	9.8±1.0	17.5±0.3	.....	+2.0±1.8
DURUM.											
Kubanka:											
Arnautka	1493	20.9	10.1±0.7	24.7±1.6	27.9±0.3	10.7±0.9	7.0±1.7	7.1±2.0	8.6±1.8	13.7	+1.1±0.7
Do	4064	[b] 20.4	10.6	[a] 25.0	27.6±0.1	11.4±0.2	6.5±1.6	6.4±1.6	5.4±0.8	13.3	+.7±0.9
Beloturka	1520	21.2	10.6	19.5±6.3	26.7±1.9	11.4±0.4	5.5±1.6	3.2±0.9	8.3±1.4	12.2	−.4±0.4
Gharnovka	1447	20.1	3.3	24.3±1.2	22.2±1.9	.....	.....	.....	.....	.....	−2.3±2.8
Kubanka	1354	19.0	13.6	22.7±5.6	.....	.....	.....	.....	.....	.....	+4.6±1.3
Do	1440	17.7	5.1	20.7±4.5	27.6±1.2	12.9±0.5	7.5±2.2	3.0±0.9	6.0±0.9	11.8	−.8±0.4
Do	1516	17.8	6.0	26.5±4.4	31.3±1.6	.....	.....	.....	.....	.....	+2.3±1.8
Kubanka No. 8	4063	.....	.....	.....	.....	4.7±1.1	7.0±2.2	.....	.....	.....	−3.7±2.9
Marouani	1593	17.3	14.1	24.0±3.9	.....	.....	.....	.....	.....	.....	+5.5±1.0

Monad	3320						6.5±2.6	2.0±0.2	8.7±2.5		− .8±0.4
Yellow Gharnovka	1444	20.9	5.3	22.5±2.9	[a] 31.2						+ .8±1.2
Peliss:											
Peliss	1584	20.0	10.5	26.6±2.5	31.6±1.0	14.4±0.3	7.8±2.1	3.7±1.1	8.8±2.1	14.8	+2.2±0.5
Red Durum:											
D–5	3322						7.8±2.8	2.5±0.9	6.5±1.9		− .9±0.6
Miscellaneous:											
Bledur	1471	20.2	8.3	25.8±0.4	[a] 33.6				8.8±2.1		+ .3
Kahla	3024	18.6	10.0	21.2±3.5							+2.0±0.4
Velvet Don	1445	19.1	7.3	25.3±6.2	28.1±1.4						+1.3±1.7

[a] One plat only.

[b] Average for only 3 years, 1910 to 1912, inclusive.

RESULTS AT AKRON, COLO.

The Akron Field Station of the Office of Dry-Land Agriculture at Akron, Colo., lies at an altitude of 4,560 feet on a sandy loam soil. The average annual precipitation for the past 16 years was 17.97 inches. Experiments with spring wheat have been conducted here since 1908 in cooperation with the Office of Dry-Land Agriculture The yields are shown in Table XIII.

During the 5-year period from 1908 to 1912, inclusive, most of the durum varieties considerably outyielded all common varieties except Galgalos. The Beloturka durum was the highest yielding variety, averaging 21.2 bushels per acre. During the 7-year period from 1913 to 1919, inclusive, the Marquis compared favorably with the durum wheats, yielding 12.6 bushels per acre and outyielding even Beloturka and Kubanka (C. I. No. 1440). Other durum wheats, however, proved better yielders in this later period. Peliss was the leading variety, yielding at the rate of 14.8 bushels per acre, or a significant difference of 2.2 bushels more than Marquis. Of the other durum wheats the Arnautka has yielded best. Several common wheats also have outyielded the Marquis, among them Galgalos and Erivan during the full period, and Prelude and Pioneer during the five years from 1915 to 1919, inclusive. The Prelude outyielded it by the greatest difference, averaging 2 bushels per acre more, although the Marquis outyielded it in three out of the five years. Not all of these differences are significant. In a long period of years, however, the Prelude might be the best common variety to grow.

SUMMARY OY YIELDS.

In order to compare the yields of varieties at all of the 11 stations, the average yields of each variety have been expressed in percentages of the yield of the Marquis variety during the same years at each station. These are given in Table XIV. A diagram showing the location of the 11 field stations and the average yields of the leading commercial varieties, in percentage of yields of the Marquis variety, at each station is shown in figure 1. The Marquis has been included in all of the experiments, and its yields here given include 66 station years. Other varieties have been grown during only a part of these years. The number of years that each variety has been grown at each station is indicated.

A study of Table XIV shows that, in general, the Marquis is the highest yielding variety of common spring wheat grown in experiments at 11 field stations in the northern half of the Great Plains area. It has been outyielded by only a few other varieties at some of the stations. The Power Fife has produced higher yields than Marquis at Williston, N. Dak., Havre, Mont., and Sheridan, Wyo. The Preston has yielded more than Marquis only at Williston, N. Dak. The yields of Haynes Bluestem are only 41 to 94.4 per cent

of the yields of Marquis. Galgalos has yielded well in the western portion of the Great Plains area, outyielding Marquis at Havre, Mont., Archer, Wyo., and Akron, Colo., but it is a white wheat. Pioneer has outyielded Marquis at Williston, N. Dak., Sheridan, Wyo., and Akron, Colo. The yields of Prelude have been relatively low at all stations except North Platte, Nebr., and Akron, Colo., where owing to the early maturity of this variety it has been able to evade summer drought in some seasons. Kitchener and Ruby in a limited number of experiments show promise of being superior to Marquis in yield.

TABLE XIV.—*Average yields of 34 varieties and strains of spring wheat grown at 11 experiment stations in the northern half of the Great Plains area during three or more station years in the 7-year period from 1913 to 1919, inclusive, expressed in percentages of the yield of the Marquis variety at the same stations in the same years.*

Class, group, and variety.	Yield per acre compared to Marquis (per cent).											
		North Dakota.			Montana.		South Dakota.		Wyoming.		North Platte, Nebr., 7 years.	Akron, Colo. 7 years.
	C. I. No.	Williston, 6 years.	Dickinson, 7 years.	Mandan, 4 years.	Havre, 4 years.	Moccasin, 7 years.	Highmore, 7 years.	Newell, 7 years.	Sheridan, 3 years.	Archer, 7 years.		
COMMON.												
Fife:												
Marquis	3641	100	100	100	100	100	100	100	100	100	100	100
Ghirka Spring	1517	a 92.3	b 75.4	.....	.....	a 90.4	a 66.2	c 91	103.2	84.4	c 88.4	93.6
Glyndon	2873	97.4	a 84.4	.....	.....	a 83.2	c 46	a 81.5	88.9	80.8	.....	82.5
Kitchener	4800	.....	.....	.....	.....	.....	.....	d 109.4	.....	d 103.4	.....	.....
Power	3697	104	b 84.7	96.5	e 109.5	89.3	c 70.2	92.3	107.1	80.1	d 52.6	e 31
Red Fife	3329	.....	85.9	.....	.....	.....	.....	.....	.....	.....	.....	.....
Do	3694	97	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Ruby	6047	.....	f 161.8	.....	.....	.....	.....	f 103	.....	d 72.2	.....	.....
Rysting	3022	.....	88.9	.....	.....	89.7	.....	a 80.4	.....	83.6	.....	.....
Early Red Fife	4932	.....	.....	.....	.....	c 85.7	.....	.....	.....	.....	.....	.....
Bluestem:												
Crossbred	3314	.....	79.4	.....	.....	.....	.....	.....	.....	e 35	.....	.....
Dakota	3083	99	.....	.....	.....	.....	e 35.9	.....	.....	.....	.....	.....
Haynes	2874	94.4	75.9	73.1	e 82.2	c 78.4	b 59.7	83.1	91.3	b 56.7	d 44.8	a 41
Preston:												
Converse	4141	.....	.....	.....	.....	.....	.....	.....	.....	97.1	.....	100
Erivan	2397	.....	.....	.....	.....	.....	e 61.1	.....	.....	116.3	.....	103.2
Pioneer	4324	c 101.2	a 94.3	.....	d 86.5	a 84.9	a 84.2	a 87	107.1	c 94	c 78.1	a 109
Preston	3081	c 106	85.9	93	e 80.2	c 90.2	91	90.7	87.3	79.4	c 83.8	b 83.6
Ladoga:												
Huron	4935	d 103.6	87.1	.....	.....	c 95.4	.....	c 94.7	.....	c 101.5	.....	.....
Laramie	6235	.....	.....	.....	.....	.....	.....	f 114.9	.....	d 99.7	.....	f 65.9
Manchuria	2492	c 94.7	e 76.8	.....	.....	.....	e 99	98.9	.....	.....	.....	f 71.6
Norka	4377	.....	.....	.....	.....	.....	.....	f 111.9	.....	107.1	.....	d 91.2
Miscellaneous:												
Galgalos	2398	.....	.....	.....	119.2	e 96.1	.....	.....	.....	109.2	d 20.3	109.5
Prelude	4323	c 79.6	a 86.8	.....	61.6	a 83.6	a 82.4	a 84.1	92.1	c 68.3	c 120.1	a 116.4
DURUM.												
Kubanka:												
Acme	5284	d 124.1	e 122.5	f 117.8	.....	.....	a 138.7	e 126.5	.....	e 111	.....	.....
Arnautka	1493	.....	.....	.....	.....	.....	.....	117.5	.....	109.2	.....	108.7
Do	4064	a 105.6	117.6	97.7	e 113.1	c 102.8	a 80.4	a 119.8	80.2	104.3	c 98.5	105.6
Beloturka	1520	.....	.....	.....	.....	e 95.8	.....	.....	.....	114.9	.....	96.8
Buford	5295	114.3	d 101.1	.....	.....	.....	f 107.8	f 123.8	.....	f 438	.....	.....
Kubanka	1440	106.9	121.2	.....	104.1	100.8	102	b 114.9	96	112	105.1	93.6
Do	1516	.....	.....	.....	.....	.....	f 33.1	123.5	.....	116	.....	e 112.7
Kubanka No. 8	4063	a 101	130	97.7	.....	d 89.6	e 68.2	d 107.3	89.7	c 113.3	c 91.6	d 61.5
Marouani	1593	.....	.....	.....	.....	.....	.....	.....	.....	107.1	.....	d 140.5
Mindum	5296	.....	d 110.3	.....	.....	.....	f 83.5	e 134.3	.....	b 308	.....	.....
Monad	3320	d 139.2	135.9	.....	.....	e 120.1	e 112	e 123.6	.....	e 105.5	.....	e 87.7
Pierson	4163	.....	.....	.....	.....	.....	a 92.7	d 118.3	.....	.....	.....	.....
Red Durum:												
D-5	3322	d 133.3	c 119.7	.....	.....	e 117.5	e 113.4	e 120.3	.....	e 97.9	.....	e 86.2
Peliss:												
Peliss	1584	.....	.....	.....	120.5	102.9	.....	.....	103.9	108.5	.....	117.5
Miscellaneous:												
Golden Ball	6227	.....	f 141.2	.....	.....	.....	f 110.6	.....	.....	f 423	.....	f 101.8

a Average for only five years.
b Average for only six years.
c Average for only four years.
d Average for only two years.
e Average for only three years.
f Average for only one year.

The better varieties of durum wheat have outyielded Marquis at all stations except Sheridan, Wyo., where the results are for only three years and are not conclusive. Of the varieties of durum wheat grown during the entire period of the experiments, Kubanka (C. I. No. 1440) has outyielded Marquis at eight of the ten stations at which it has been grown. It gave the poorest comparative yields at Akron, Colo., where it yielded only 93.6 per cent as much as Marquis, and the best comparative yields at Dickinson, N. Dak., where its yield was 121.2 per cent. Kubanka (C. I. No. 1516) has a higher, comparative yield than Kubanka (C. I. No. 1440) at three of the four stations where both have been grown. In comparison with Marquis the percentage of yield of Kubanka No. 8 (C. I. No. 4063) is less than the yield of Kubanka (C. I. No. 1440) at all stations except Dickinson, N. Dak., and Archer, Wyo. At Dickinson, N. Dak., the yields of Kubanka No. 8 (C. I. No. 4063) have been significantly higher than that of Kubanka (C. I. No. 1440), but less than the yields of Monad. Strains of Kubanka have produced higher average yields than Arnautka at most of the stations. Peliss has the highest average yields at Havre and Moccasin, Mont., Sheridan, Wyo., and Akron, Colo. From these results Peliss is considered to be more productive than Kubanka and Arnautka in the western portions of the Great Plains area. Of the rust-resistant varieties of durum wheat, Acme, Monad, and D–5, the Acme and Monad have higher comparative yields than D–5, the red durum, at nearly all stations where grown. and are also higher than most other durum varieties. At all stations where it has been grown, D–5 has been outyielded by either Acme or Monad or by both of them.

DAYS FROM EMERGENCE TO MATURITY.

Notes on the dates of emergence and maturity of the varieties of wheat have been recorded each year at nearly all of the field stations. The ripening of wheat in the northern half of the Great Plains area occurs prematurely in most of the seasons, owing to drought, hot winds, or rust. In moderately unfavorable seasons the period from emergence to maturity is shorter and the difference in the time of maturity between early and late varieties is less than for the same varieties in a normal ripening season, such as usually occurs in the subhumid and humid areas. In very unfavorable seasons hot winds ripen, or rather "deaden," all varieties of wheat at almost the same time, regardless of their relative normal periods of development. Thus, there is a wide variation in the time of maturity of the same variety of wheat in different seasons in the northern Great Plains.

The period from emergence to maturity for Marquis wheat varied from 72 days at Mandan, N. Dak., in 1919, to 125 days at Moccasin, Mont., in 1915. At Dickinson, N. Dak., the period varied from 76

days in 1919 to 121 days in 1915. In general, the period from emergence to maturity is less in the northern than in the southern parts of the section, but the seasonal climatic differences, including precipitation, temperature, humidity, and wind, are the most important determining factors. The earlier the wheat is sown the longer will be the period from emergence to maturity. The average number of days from emergence to maturity of 38 varieties of spring wheat grown at 11 experiment stations in the northern half of the Great Plains area during three or more of the seven years from 1913 to 1919, inclusive, compared with Marquis wheat grown at the same station in the same years is shown in Table XV.

TABLE XV.—*Average time from emergence to maturity of 38 varieties of spring wheat grown at 11 experiment stations in the northern half of the Great Plains area during three or more of the seven years from 1913 to 1919, inclusive, compared with the Marquis variety for the same station years.*

Class, group, and variety.	C. I. No.	Station years.	Average time from emergence to maturity (days).			
			Variety named.	Marquis for same station years.	Difference from Marquis.	
					Earlier.	Later.
COMMON.						
Fife:						
Marquis	3641	56	94.8			
Ghirka Spring	1517	42	96.9	96.5		0.4
Glyndon	2873	42	98.6	95.7		2.9
Kitchener	4800	3	91.	91.7	0.7	
Power	3697	49	97.2	94.1		3.1
Red Fife	3329	7	100.1	95.2		4.9
Ruby	6047	4	82.8	87.7	4.9	
Rysting	3022	26	101.9	98.1		3.8
Bluestem:						
Crossbred	3314	7	101.6	95.2		6.4
Dakota	3083	8	98.4	94.8		3.6
Haynes	2874	47	98.2	93.6		4.6
Preston:						
Converse	4141	14	96.9	98.3	1.4	
Erivan	2397	17	92.8	97.3	4.5	
Fretes	1596	7	105.7	107.	1.3	
Pioneer	4324	34	90.9	95.2	4.3	
Preston	3081	50	94.3	93.5		.8
Ladoga:						
Huron	4935	18	95.4	95.5	.1	
Laramie	6235	4	91.7	91.3		.4
Manchuria	2492	16	93.6	95.3	1.7	
Norka	4377	7	97.4	94.6		2.8
Miscellaneous:						
Prelude	4323	36	85.4	95.4	10.0	
Galgalos	2398	19	99.1	100.	.9	
DURUM.						
Kubanka:						
Acme	5284	15	91.3	88.1		3.2
Algeria	3310	6	82.2	87.3	5.1	
Arnautka	1493	20	97.6	95.5		2.1
Do	4064	46	97.8	94.4		3.4
Beloturka	1520	17	101.9	100.1		1.8
Buford	5295	9	94.8	92.7		2.1
Kubanka	1440	51	98.3	95.8		2.5
Do	1516	17	96.6	93.9		2.7
Kubanka No. 8	4063	32	96.6	93.3		3.3
Marouani	1593	9	100.2	96.8		3.4
Mindum	5296	4	89.5	85.7		3.8
Monad	3320	21	96.0	93.3		2.7
Pierson	4163	6	90.	87.3		2.7
Red Durum:						
D-5	3322	18	94.4	92.		2.4
Peliss:						
Peliss	1584	26	102.1	99.6		2.5
Miscellaneous:						
Golden Ball	6227	4	89.	84.		5.0

The Prelude and Ruby varieties are the earliest which have been grown in these experiments, being 10 days and 4.9 days, respectively, earlier than Marquis wheat. Power Fife is 3.1 days later than Marquis on the average, although in certain instances in comparable experiments it has ripened on the same day. Haynes Bluestem has matured from 1 to 10 days later than Marquis, and during 47 station

years has averaged 4.6 days later. The average difference in time of maturity between Preston and Marquis during 50 station years is only 0.8 day, showing the Preston variety to be less than one day later than Marquis. All varieties of durum wheat grown are later than Marquis, except the Algeria, which has been grown only at Highmore, S. Dak. Most varieties of durum wheat mature in about the same average period of two to four days later than Marquis under the same conditions.

HEIGHT OF PLANT.

The height of the wheat plant is of economic importance because it determines the methods or ease of harvesting. The height of different varieties of wheat, as measured from the surface of the ground to the tip of the spike, has varied greatly in these experiments. The average height of Marquis wheat during 57 station years in this semiarid section is 29.4 inches, but its stature has varied from 17 to 48 inches. The height of Marquis wheat at Dickinson, N. Dak., was 43 inches in 1915 but only 18 inches in 1919. The height of the wheat plant is determined by the amount of elongation of the internodes of the culm and is influenced by numerous soil and climatic factors. In the northern half of the Great Plains the height is affected chiefly by the climate, including the amount of soil moisture, which is the result of the annual precipitation. The height of the wheat plant is increased by high soil fertility, abundant moisture, humid atmosphere, moderately cool temperature, and other factors which favor vegetative growth at the time of heading. In general, early varieties are shorter than late varieties. Late varieties, which are normally quite tall, are sometimes shorter than short early varieties in seasons having drought or hot winds at heading time. When the drought, temperatures, or hot winds are extreme, the heads of wheat may not be entirely exserted from the sheath.

The height of plant of 38 varieties of spring wheat grown at one or more of 11 stations in the northern half of the Great Plains area during three or more station years from 1913 to 1919 is shown in Table XVI.

The Marquis variety is shorter than most of the common wheats and than all but one variety of durum wheat. The Galgalos and Huron varieties are both taller than the Marquis under favorable conditions, but they are easily affected by dry soil and atmosphere, so that their height is less than Marquis in many dry seasons. During 18 station years the Huron had an average height of 0.8 inch less than Marquis, while during 20 station years the Galgalos had an average height of 2.0 inches less than Marquis. During 44 station years Power Fife has averaged 0.1 inch shorter than Marquis. At Williston, N. Dak., however, where climatic conditions are favorable for Power Fife, it is from 2 to 4 inches taller than Marquis. In that district and a few

others this difference is recognized by farmers to such an extent that they sow Marquis only on rich or moist soil, such as summer fallow or corn ground, and Power Fife on land continuously cropped to small grain. If they sow Marquis on land following other crops of small grain, it often is too short to be harvested with a binder and much greater loss results than if Power Fife were grown. The Erivan, Fretes, Prelude, and Algeria varieties are all earlier than Marquis and also somewhat shorter. Most of the commercial varieties of durum wheat are from 4 to 6 inches taller than Marquis in the northern Great Plains. The rust-resistant varieties, Acme, Monad, and D–5, are from 2 to 3 inches shorter than Kubanka and Arnautka.

TABLE XVI.—*Average height of plant of 38 varieties of spring wheat grown at one or more of the 11 experiment stations in the northern half of the Great Plains area during three or more station years in the 7-year period from 1913 to 1919, inclusive, compared with the Marquis variety for the same station years.*

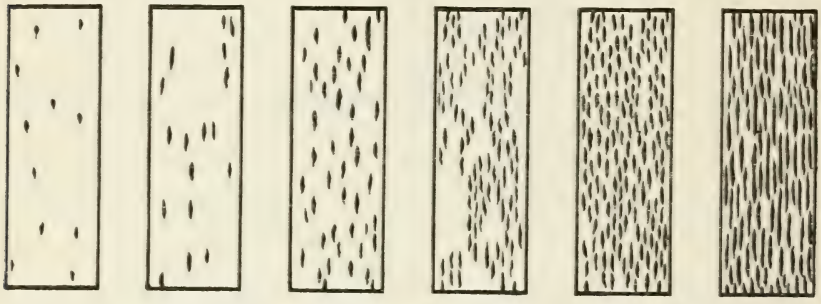
Class, group, and variety.	C. I. No.	Station years.	Average height of plant (inches).			
			Variety named.	Marquis for same station years.	Difference from Marquis.	
					Taller.	Shorter.
COMMON.						
Fife:						
Marquis	3641	57	.....	29.4	.....	.....
Ghirka Spring	1517	42	32.0	31.0	1.0	.....
Glyndon	2873	43	30.5	30.0	.5	.....
Kitchener	4800	3	30.3	28.3	2.0	.....
Power	3697	44	28.3	28.4	.....	0.1
Red Fife	3329	7	33.1	32.4	.7	.....
Ruby	6047	4	26.0	25.7	.3	.....
Rysting	3022	25	32.3	30.7	1.6	.....
Bluestem:						
Crossbred	3314	7	34.7	32.4	2.3	.....
Dakota	3083	8	33.7	30.2	3.5	.....
Haynes	2874	50	30.9	28.6	2.3	.....
Preston:						
Converse	4141	14	27.7	26.3	1.4	.....
Erivan	2397	17	24.3	26.7	.....	2.4
Fretes	1596	7	33.7	34.7	.....	1.0
Pioneer	4324	34	29.5	28.9	.6	.....
Preston	3081	50	28.7	27.9	.8	.....
Ladoga:						
Huron	4935	18	29.4	30.6	.....	.8
Laramie	6235	4	29.0	28.5	.5	.....
Manchuria	2492	17	34.4	32.4	2.0	.....
Norka	4377	6	27.5	27.0	.5	.....
Miscellaneous:						
Prelude	4323	35	27.0	29.0	.....	2.0
Galgalos	2398	20	26.8	28.8	.....	2.0
DURUM.						
Kubanka:						
Acme	5284	16	29.0	26.9	2.1	.....
Algeria	3310	4	25.2	28.7	.....	3.5
Arnautka	1493	20	31.9	27.1	4.8	.....
Do	4064	47	34.6	28.9	5.7	.....
Beloturka	1520	17	35.1	29.7	5.4	.....
Buford	5295	10	34.7	27.5	7.2	.....
Kubanka	1440	52	33.8	29.6	4.2	.....
Do	1516	17	30.1	27.7	2.4	.....
Kubanka No. 8	4063	31	35.3	29.6	5.7	.....
Marouani	1593	9	32.0	26.2	5.8	.....
Mindum	5296	5	27.8	23.6	4.2	.....
Monad	3320	21	30.5	28.9	1.6	.....
Pierson	4163	6	31.0	29.5	1.5	.....
Red Durum:						
D–5	3322	18	27.8	25.5	2.3	.....
Peliss:						
Peliss	1584	25	32.5	28.6	3.9	.....
Miscellaneous:						
Golden Ball	6227	4	26.8	24.5	2.3	.....

STEM-RUST INFECTION.

Stem rust (*Puccinia graminis tritici*) is very destructive to spring wheat in the northern half of the Great Plains area. Fortunately, however, this disease usually is limited to the eastern portion of this section. In 1916 and 1919 very serious epidemics occurred, which in extreme cases reduced the yield of wheat 75 to 100 per cent. Some damage from rust occurs at a few of the stations nearly every year.

When rust occurs on the varieties grown at field stations the percentage of infection usually is recorded, This is estimated by examining the wheat plants and comparing them with the standard scale shown in figure 2. On this scale 100 per cent infection means that 37 per cent of the surface of the culms is covered by rust pustules. An infection of 10 per cent or more is sufficient to cause a noticeable reduction in yield, while 100 per cent infection of black stem rust usually results in a total failure of the crop. The quality of the wheat also is injured by rust.

Data on stem-rust infection have been obtained at seven stations for one to five years, with a total of 20 station years for some varieties. Stem rust was recorded in 1914 at Highmore, S. Dak., and Akron, Colo.; in 1915, at Dickinson, N. Dak., Newell, S. Dak., Archer, Wyo., and Akron, Colo.; in 1916, at Williston, Dickinson, and Mandan, N. Dak., Highmore and Newell, S. Dak., and Archer, Wyo.; in 1917, at



A, 5 per cent. B, 10 per cent. C, 25 per cent. D, 40 per cent. E, 65 per cent. F, 100 per cent.

FIG. 2.—Scale for estimating rust, illustrating six degrees of rustiness used in estimating the percentage of stem-rust infection. The shaded spots represent rust, and the figures represent approximately the rust percentages computed on the basis of the maximum of surfaces covered by rust as shown in the 100 per cent figure (F). Figure F in the diagram represents 37 per cent of actual rust-covered surface and is arbitrarily selected as 100 per cent. The other percentages are in terms of figure F.

Highmore, S. Dak.; in 1918, at Mandan, N. Dak., Highmore, S. Dak., and Archer, Wyo.; in 1919, at Mandan, N. D., Highmore, S. Dak., Archer, Wyo., and Akron, Colo. Stem rust has not occurred at Moccasin, Mont., in the seven years from 1913 to 1919, or at Havre, Mont., or Sheridan, Wyo., during the periods of the experiments. Rust notes were not recorded on the varieties at North Platte, Nebr. The average percentages of stem-rust infection on 30 varieties of wheat in comparison with Marquis are shown in Table XVII.

Marquis wheat shows an average stem-rust infection of 17.7 per cent in 20 station years. All important commercial varieties of common spring wheat show a higher percentage of rust infection than Marquis. A few early varieties of common wheat show less rust, but most of the later varieties of common wheat show a higher infection. Haynes Bluestem, a late-maturing variety, shows the highest percentage of infection, averaging 31.6 per cent in 19 station years. None of the varieties of common wheat shown here is really

rust resistant, but early-maturing varieties have ripened before the rust has developed extensively and are sometimes rust escaping. In general, the early-maturing varieties of common wheat show a lower percentage of rust infection than late-maturing varieties. A few varieties of common wheat which show a small percentage of rust infection have been grown only at stations where the rust epidemics have been less severe.

TABLE XVII.—*Average stem-rust infection of 30 varieties of spring wheat grown at seven experiment stations in the northern half of the Great Plains area during three or more years in which rust occurred in the 7-year period from 1913 to 1919, inclusive, compared with the Marquis variety for the same station years.*

Class, group, and variety.	C. I. No.	Station years.	Stem-rust infection (per cent).			
			Variety named.	Marquis for same station years.	Difference from Marquis.	
					Greater.	Less.
COMMON.						
Fife:						
Marquis	3641	20	17.7	.....	.....	.....
Ghirka						
Spring	1517	15	23.9	17.1	6.8	.....
Glyndon	2873	13	21.4	16.3	5.1	.....
Power	3697	17	26.9	19.9	7	.....
Rysting	3022	8	30.9	20.2	10.7	.....
Bluestem:						
Haynes	2874	19	31.6	18.4	13.2	.....
Preston:						
Converse	4141	7	13.1	10.7	2.4	.....
Erivan	2397	7	8.3	13.1	.....	4.8
Pioneer	4324	13	17.4	20.8	.....	3.4
Preston	3081	20	23.8	17.7	6.1	.....
Ladoga:						
Huron	4935	7	25.7	22.1	3.6	.....
Laramie	6255	3	13.	19.3	.....	6.3
Manchuria	2492	5	10.4	17	.....	6.6
Norka	4377	4	14.	17	.....	3.0
Miscellaneous:						
Prelude	4323	14	12.4	19.6	.....	7.2
Galgalos	2398	7	7.7	18.4	.....	10.7
DURUM.						
Kubanka:						
Acme	5284	8	2.1	19.4	.....	17.3
Algeria	3310	4	6.7	25	.....	18.3
Arnautka	1493	9	7.9	13.6	.....	5.7
Do	4064	19	12.2	17.5	.....	5.3
Beloturka	1520	3	3.7	5	.....	1.3
Buford	5295	3	20	25	.....	5
Kubanka	1440	16	7.1	17.9	.....	10.8
Do	1516	6	6.7	17.8	.....	11.1
Kubanka						
No. 8	4063	12	11.1	20.9	.....	9.8
Marouani	1593	5	9.6	12.6	.....	3.0
Monad	3320	8	4	22.9	.....	18.9
Pierson	4163	4	22.5	25	.....	2.5
Red Durum:						
D–5	3322	6	2.5	21.3	.....	18.8
Peliss:						
Peliss	1584	5	6.2	12.8	.....	6.6
Miscellaneous:						
Golden Ball	6227	3	7.0	24.7	.....	17.7

Most varieties of durum wheat are more or less rust resistant, as compared with common wheats. All varieties shown in Table XVII are more resistant than Marquis. Three varieties, Acme, Monad, and D–5, are known to be especially rust resistant. During years of heavy rust infection these varieties have produced the highest yields. When grown under comparable conditions in these and other experiments, the D–5 variety shows the greatest resistance of all varieties to stem rust. Table XVII shows the Acme to have the lowest infection of stem rust, 2.1 per cent, which is 17.3 per cent less than Marquis during the same station years. The Monad shows an average stem-rust infection of 4 per cent, which is 18.9 per cent less than Marquis in the same station years, while the D–5 variety shows an infection of only 2.5 per cent, with a difference from

Marquis of 18.8 per cent during the same station years. Although a high-yielding variety in seasons of rust epidemics, the D–5 wheat is only a fair yielder when rust is not a factor. Arnautka (C. I. No. 1493) shows a higher percentage of rust than Kubanka (C. I. No. 1440), the Arnautka having only 5.7 per cent less rust, while the Kubanka had 10.8 per cent less rust than Marquis. Two pure-line selections of these varieties, Arnautka (C. I. No. 4064) and Kubanka No. 8 (C. I. No. 4063), have each a higher percentage of rust infection than the original unselected varieties mentioned above. Kubanka (C. I. No. 1516), from which the Acme variety was selected, shows slightly less rust infection than Kubanka (C. I. No. 1440). In 1919, Golden Ball proved to be somewhat resistant. Owing to the limited data the rust infection of the Mindum variety of durum wheat is not shown in Table XVII, but this variety is known to be much more resistant than Arnautka. The Pierson and Buford have the highest percentage of infection of all durum varieties shown in Table XVII.

BUSHEL WEIGHT.

The bushel weight of all varieties of wheat at the 11 stations has been determined nearly every year by the use of a standard test kettle. The weights have varied according to seasonal conditions. In the northern half of the Great Plains area the frequency of drought, hot winds, rust, and scab has resulted in shrunken kernels having low bushel weights during most of the years.

The average bushel weight of 38 varieties of spring wheat grown in the northern half of the Great Plains area is shown in Table XVIII.

The average bushel weights of spring wheats, as shown in Table XVIII, are practically all less than the standard weight of 60 pounds per bushel, and nearly all less than the weights for the No. 1 grade. In experiments covering 57 station years in the northern half of the Great Plains, the average bushel weight of Marquis has been 56.3 pounds. At Highmore, S. Dak., in 1916, the weight of Marquis was only 42 pounds, owing to the rust epidemic, but at Newell, S. Dak., in 1915, a very favorable season, Marquis had a bushel weight of 62.5 pounds.

None of the common spring varieties in the Fife and Bluestem groups had a higher bushel weight than Marquis, and Ruby was the only variety in these groups which had a weight equal to that of Marquis. Preston in 52 station years had an average weight of 57.4 pounds per bushel, or 1.4 pounds heavier than Marquis. The differences in bushel weight in either class of wheat shown in Table XVIII are due almost exclusively to differences in plumpness. Nearly all of the common varieties which were heavier than Marquis were slightly earlier and awned and evidently more evasive of drought and disease.

TABLE XVIII.—*Average bushel weight of 38 varieties of spring wheat grown at 11 experiment stations in the northern half of the Great Plains area during three or more of the seven years from 1913 to 1919, inclusive, compared with the Marquis variety for the same station years.*

Class, group, and variety.	C. I. No.	No. of station years.	Average bushel weight (pounds).			
			Variety named.	Marquis for same station years.	Difference from Marquis.	
					Heavier.	Lighter.
COMMON.						
Fife:						
Marquis	3641	57	56.3	.....	.....	.....
Ghirka Spring	1517	41	55.1	56.0	.....	0.9
Glyndon	2873	42	54.9	56.5	.....	1.6
Kitchener	4800	3	53.7	55.7	.....	2.0
Power	3697	51	55.9	56.1	.....	.2
Red Fife	3329	6	54.6	56.6	.....	2.0
Ruby	6047	3	58.2	58.2	.....	0.
Rysting	3022	24	55.0	56.9	.....	1.9
Bluestem:						
Crossbred	3314	7	52.6	56.1	.....	3.5
Dakota	3083	9	54.2	57.5	.....	3.3
Haynes	2874	47	53.1	56.0	.....	2.9
Preston:						
Converse	4141	13	57.1	56.2	0.9	.....
Erivan	2397	16	55.7	55.6	.1	.....
Fretes	1596	6	59.2	59.6	.....	.4
Pioneer	4324	35	56.5	56.1	.4	.....
Preston	3081	52	57.4	56.0	1.4	.....
Ladoga:						
Huron	4935	17	55.2	56.6	.....	1.4
Laramie	6235	4	56.2	55.6	.6	.....
Manchuria	2492	17	55.6	55.8	.....	.2
Norka	4377	7	60.2	57.7	2.5	.....
Miscellaneous:						
Galgalos	2398	19	58.0	56.9	1.1	.....
Prelude	4323	34	57.5	56.2	1.3	.....
DURUM.						
Kubanka:						
Acme	5284	16	59.8	56.2	3.6	....
Algeria	3310	4	56.0	52.5	3.5	....
Arnautka	1493	19	59.3	55.4	3.9	....
Do	4064	49	58.5	56.4	2.1	....
Beloturka	1520	16	59.6	56.8	2.8	....
Buford	5295	11	60.4	58.0	2.4	....
Kubanka	1440	49	59.5	56.4	3.1	....
Do	1516	18	59.5	55.8	3.7	....
Kubanka No. 8	4063	35	59.4	56.2	3.2	....
Marouani	1593	8	58.3	57.9	.4	....
Mindum	5296	5	59.2	55.9	3.3	....
Monad	3320	21	59.3	55.9	3.4	....
Pierson	4163	6	54.3	54.0	.3	....
Red Durum:						
D-5	3322	18	59.9	56.7	3.2	....
Peliss:						
Peliss	1584	24	59.6	57.4	2.2	....
Miscellaneous:						
Golden Ball	6235	3	55.3	52.8	2.5	....

Durum wheats are heavier than common spring wheats grown under the same conditions, and in addition to their greater specific gravity they also are less injured by drought and rust. Arnautka (C. I. No. 1493), Kubanka (C. I. No. 1516), and Acme show the highest bushel weights as compared with Marquis.

MILLING AND BAKING EXPERIMENTS.

The leading varieties of spring wheat grown at the 11 experiment stations in the northern half of the Great Plains area have been milled in an experimental mill and the flour baked into bread, to determine their value for flour and bread making. When possible, samples from all stations have been milled each year from 1915 to 1918, inclusive. In addition, samples grown at Dickinson, N. Dak., in 1913 and 1914, are included. The milling and baking experiments were conducted in cooperation with the Office of Grain Standardization from 1913 to 1917, inclusive. During these years the milling laboratory was operated at Fargo, N. Dak., in cooperation with the chemistry department of the North Dakota Agricultural Experiment

Station. Since 1918, the laboratory has been located at Washington, D. C., and the experiments have been conducted in cooperation with the division of milling investigations of the Bureau of Markets. The nitrogen determinations have been made since 1918 by the Bureau of Chemistry of the United States Department of Agriculture and by the research laboratory of the Bureau of Markets. Complete data regarding the flour and bread producing qualities of each lot of wheat have been obtained, but data on only three important factors are presented here. These are percentage of crude protein in the wheat, percentage of straight flour in the wheat, and loaf volume (in cubic centimeters) of bread baked from 340 grams of flour. The average results shown here are from varieties grown during three or more station years. The average data obtained from two samples is an indication of milling and bread-making value, but three or more samples should be milled and baked before definite conclusions are drawn.

CRUDE PROTEIN IN WHEAT.

Each sample of wheat is analyzed for nitrogen. The percentage of crude protein is the percentage of nitrogen multiplied by the factor 5.7. The result is then computed to a standard basis of 13.5 per cent moisture in the wheat, as all samples vary somewhat in moisture content. The protein content of wheat is an indication of the strength of the flour and of the gluten content. The best wheats contain considerable protein, but as there are other important characters this should not be used alone in making comparisons. The average percentages of protein in 20 varieties of spring wheat, compared with Marquis wheat during the same station years, are shown in Table XIX.

Marquis wheat has an average protein content of 15.3 per cent. Most of the common spring wheats have about the same protein content as Marquis. Ghirka Spring and Galgalos are softer wheats and have distinctly less protein. Huron also has a low percentage of protein. The Prelude and Pioneer varieties are early-maturing hard red wheats having a high protein content. The Manchuria is a very soft wheat and is poor in all milling and baking factors except that it has a high average protein content.

The durum wheats in these experiments have about the same percentage of protein as Marquis. Monad is the only variety showing a distinctly greater protein content.

TABLE XIX.—*Crude protein in 20 varieties of spring wheat grown at 11 experiment stations in the northern half of the Great Plains area during three or more of the six years from 1913 to 1918, inclusive, compared with the Marquis variety for the same station years.*

Class, group, and variety.	C. I. No.	Station years.	Crude protein (per cent).[1]			
			Variety named.	Marquis for same station years.	Difference from Marquis.	
					Greater.	Less.
COMMON.						
Fife:						
Marquis	3641	36	15.3	.....	.....	.....
Ghirka Spring	1517	30	14.2	15.2	.....	1.0
Glyndon	2873	25	15.2	15.2	.....	0
Power	3697	30	15.3	15.1	0.2	.....
Red Fife	3329	4	14.3	14.1	.2	.....
Bluestem:						
Haynes	2874	32	15.3	15.3	.....	0
Preston:						
Pioneer	4324	27	16.0	15.3	.7	.....
Preston	3081	36	15.2	15.3	.....	.1
Ladoga:						
Huron	4935	4	12.8	13.6	.....	.8
Manchuria	2492	5	14.2	13.5	.7	.....
Miscellaneous:						
Galgalos	2398	3	17.0	17.6	.....	.6
Prelude	4323	28	16.2	15.3	.9	.....
DURUM.						
Kubanka:						
Acme	5284	5	16.0	15.6	0.4	.....
Arnautka	4064	35	15.6	15.3	.3	.....
Buford	5295	3	13.4	13.7	.....	0.3
Kubanka	1440	33	15.1	15.3	.....	.2
Kubanka No. 8	4063	24	14.9	15.3	.....	.4
Monad	3320	5	15.4	14.1	1.3	.....
Red Durum:						
D-5	3322	4	15.3	15.1	.2	.....
Peliss:						
Peliss	1584	11	16.6	16.4	.2	.....

[1] Crude protein equals nitrogen × 5.7 computed to a basis of 13.5 per cent moisture in the wheat.

YIELD OF FLOUR.

Samples containing about 1,500 grams of wheat are ground in a series of small roller mills to determine the percentage of flour. The bran, shorts, and flour are separated by bolting. Only one grade, called straight flour, has been separated in the experimental milling. The flour obtained is weighed, and the percentage is determined from the quantity of wheat milled. The flour yield of a wheat sample depends largely on the plumpness of the kernel. Marquis wheat shrunken from rust has yielded as low as 56.4 per cent of flour, whereas under favorable growing conditions it has produced as high as 75.8 per cent of flour. There is a wide difference in the flour yield of different varieties of wheat grown under the same conditions. This is sometimes due to the seasonal effect on the plumpness of kernel of certain varieties. A few varieties, however, produce significantly low or high average percentages of flour. The flour yields of 20 varieties of spring wheat grown at 11 experiment stations in the northern half of the Great Plains area during three or more station years are shown in Table XX.

The average yield of flour obtained from 37 samples of Marquis wheat was 70.2 per cent. Ghirka Spring, Manchuria, and Galgalos produced distinctly lower percentages of flour than Marquis. They are all softer wheats. Preston and Haynes produced about the

same percentage of flour as Marquis. Prelude was the only variety of common spring wheat which had a distinctly higher flour yield than Marquis, the difference being 2.6 per cent.

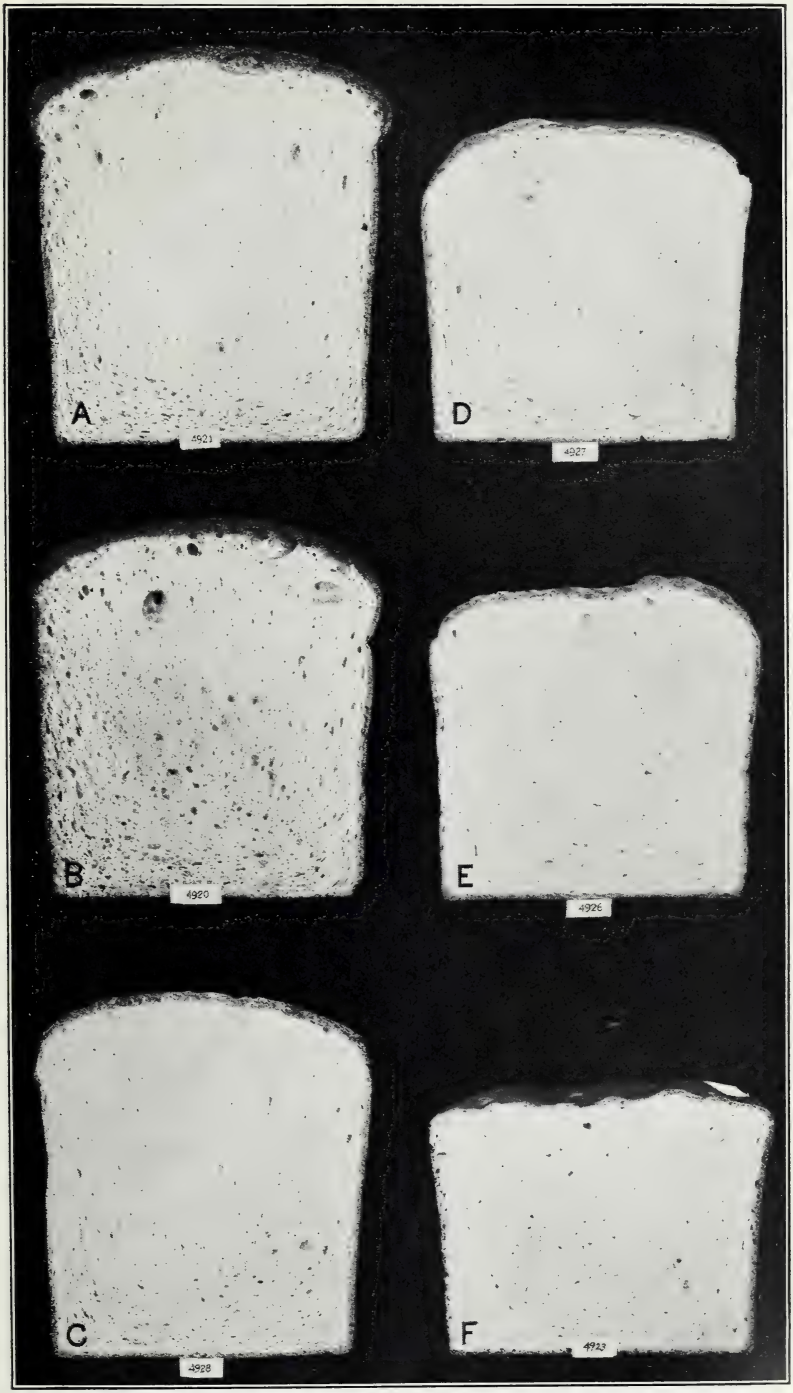
TABLE XX.—*Flour obtained from milling 20 varieties of spring wheat grown at 11 experiment stations in the northern half of the Great Plains area during three or more of the six years from 1913 to 1918, inclusive, compared with the Marquis variety for the same station years.*

Class, group, and variety.	C. I. No.	Station years.	Yield of flour (per cent).			
			Variety named.	Marquis for same station years.	Difference from Marquis.	
					Greater.	Less.
COMMON.						
Fife:						
Marquis	3641	37	70.2	.....	.....	.....
Ghirka Spring	1517	31	65.8	70.0	.....	4.2
Glyndon	2873	26	69.6	70.7	.....	1.1
Power	3697	28	70.7	70.0	0.7	.....
Red Fife	3329	4	71.2	70.2	1.0	.....
Bluestem:						
Haynes	2874	33	70.1	70.3	.....	.2
Preston:						
Pioneer	4324	32	71.1	70.4	.7	.....
Preston	3081	37	70.4	70.2	.2	.....
Ladoga:						
Huron	4935	4	68.6	68.0	.6	.....
Manchuria	2492	5	67.8	70.9	.....	3.1
Miscellaneous:						
Galgalos	2398	3	67.6	70.4	.....	2.8
Prelude	4323	29	72.8	70.2	2.6	.....
DURUM.						
Kubanka:						
Acme	5284	5	71.9	69.5	2.4	....
Arnautka	4064	35	70.7	70.1	.6	....
Buford	5295	3	74.8	72.9	1.9	....
Kubanka	1440	31	70.7	70.0	.7	....
Kubanka No. 8	4063	26	71.5	69.4	2.1	....
Monad	3820	5	71.5	69.0	2.5	....
Red Durum:						
D–5	3322	4	67.8	71.7	.....	3.9
Peliss:						
Peliss	1584	12	70.6	70.4	0	....

All strains of durum wheat yielded a higher percentage of flour than Marquis except the D–5 variety. This is the red-kerneled durum wheat graded as "Red Durum" which has been claimed to be of poor milling value. These experimental results, showing 3.9 per cent less flour than Marquis, are in accord with commercial findings. Monad and Acme wheats show the highest percentages of flour of any of the durum wheats, as compared with Marquis, being higher by 2.5 and 2.4 per cent, respectively.

VOLUME OF LOAF.

Bread has been baked from flour of each variety of wheat milled. The bakings are made in duplicate, using the same flour on two successive days. All varieties are treated alike from the first mixing until the baking is completed, 340 grams of flour and equal quantities of all other ingredients except water being used for each variety. The volume of each loaf is measured and recorded in cubic centimeters. The average volume of the two loaves baked on successive days finally is recorded as the correct loaf volume for the sample. (Pl. III.)



LOAVES OF BREAD FROM SIX VARIETIES OF WHEAT GROWN AT MOCCASIN, MONT., IN 1918.

The varieties, with the average loaf volumes, are as follows: *A*, Marquis, 2,160 c. c.; *B*, Haynes Bluestem, 2,070 c. c.; *C*, Preston, 2,050 c. c.; *D*, Kubanka, 1,730 c. c.; *E*, Peliss, 1,710 c. c.; and *F*, D-5, 1,510 c. c.

The loaf volume is a good measure of the expansion or strength of the dough, the quantity and quality of gluten, and the resulting texture and lightness of the bread. Flour of poor quality will not produce a light loaf of bread without making the texture too porous. The average volumes of loaves of bread baked from flour of 20 varieties of spring wheat grown at 11 experiment stations in the northern half of the Great Plains area are shown in Table XXI.

TABLE XXI.—*Average volume of loaves of bread made from 20 varieties of spring wheat grown at 11 experiment stations in the northern half of the Great Plains area during three or more of the six years from 1913 to 1918, inclusive, compared with the Marquis variety for the same station years.*

Class, group, and variety.	C. I. No.	Station years.	Loaf volume (cubic centimeters).				Class, group, and variety.	C. I. No.	Station years.	Loaf volume (cubic centimeters).			
			Variety named.	Marquis for same station years.	Difference from Marquis.					Variety named.	Marquis for same station years.	Difference from Marquis.	
					Smaller.	Larger.						Smaller.	Larger.
COMMON.							DURUM.						
Fife:							Kubanka:						
Marquis	3641	37	2,342	.....	.....	.....	Acme	5284	3	1,843	2,473	630	.....
Ghirka Spring	1517	31	2,139	2,351	212	.....	Arnautka	4064	35	1,993	2,332	339	.....
Glyndon	2873	26	2,165	2,328	163	.....	Buford	5295	3	1,565	2,465	900	.....
Power	3697	32	2,095	2,349	254	.....	Kubanka	1440	33	2,033	2,328	295	.....
Red Fife	3329	4	2,470	2,503	33	.....	Kubanka No. 8	4063	24	2,001	2,318	317	.....
Bluestem:							Monad	3320	5	2,087	2,457	370	.....
Haynes	2874	32	2,232	2,335	103	.....							
Preston:							Red Durum:						
Pioneer	4324	32	2,335	2,339	4	.....	D-5	3322	4	1,605	2,375	770	.....
Preston	3081	37	2,207	2,342	135	.....							
Ladoga:							Peliss:						
Huron	4935	4	2,431	2,501	70	.....	Peliss	1584	12	1,852	2,219	367	.....
Manchuria	2492	5	1,838	2,455	617	.....							
Miscellaneous:													
Galgalos	2398	3	2,100	2,057	.....	43							
Prelude	4323	25	2,298	2,324	26	.....							

The average loaf volume of 37 samples of Marquis flour was 2,342 cubic centimeters, individual samples varying from 1,900 to 2,740 cubic centimeters. Flour from Marquis wheat produces loaves having a greater volume than those from any other variety of wheat except one. The Galgalos, a white wheat, has a slightly higher average loaf volume than Marquis. This result was obtained from only three samples of wheat grown under extremely dry conditions which were unfavorable to the quality of Marquis. As the Galgalos has a lower percentage of protein and a much lower percentage of flour than Marquis, the difference found is not considered reliable. The early-maturing varieties Prelude and Pioneer, which have higher protein content and higher yields of flour than Marquis, also have loaf volumes nearly equal with it. The Manchuria has the smallest loaf volume of any of the common wheats, being 617 cubic centimeters smaller than Marquis

The durum varieties have smaller loaf volumes than the common hard red spring-wheat varieties. Buford and D–5 have the smallest loaf volumes of any of the durum wheats. The Kubanka strains, C. I. No. 1440 and C. I. No. 4063, have the highest average of all of the durum wheats.

SUMMARY OF RESULTS.

Following is a summary of the results from the 11 field stations in the northern half of the Great Plains area:

(1) The average annual precipitation at the various stations during the 7-year period from 1913 to 1919, inclusive, has been between 13 and 19 inches. Drought and diseases have occurred in several of the years, causing premature ripening, low yields, and poor quality of wheat.

(2) No less than 75 varieties and strains of spring wheat have been grown in plats and yields and other important agronomic data obtained, such as height of plant, time of maturity, rust infection, and bushel weight. Samples of many of the varieties have been milled and bread baked from the flour.

(3) Two classes of wheat have been grown, common and durum. Common wheat, as here represented by hard red spring varieties, is best for bread making. The durum wheats have generally outyielded the common wheats and also have been more resistant to rust and drought. The better varieties of durum wheat yield a higher percentage of flour than common wheat, are equal or superior to common wheat in crude protein, but have a weak gluten as revealed in a lower volume of loaf.

(4) Of the common wheats the Marquis is the leading variety. Since 1913, when it was first introduced into the United States, it has become more widely grown than all other varieties of spring wheat. For this reason and because it has been grown at all of the 11 stations each year, it has been used in this bulletin as the standard of comparison. In general, it has been the highest yielding variety. It is short strawed, early maturing, which sometimes enables it to escape rust, although susceptible, and has the highest milling and bread-making value.

(5) Of the other commercial varieties of common wheat the Power Fife is better adapted than the Marquis in northwestern North Dakota and northeastern Montana, because of larger yields and greater height. Its milling value is only slightly inferior to Marquis wheat. The Haynes Bluestem has yielded less than the Marquis at all stations, is later, has rusted severely, causing a low bushel weight, and is slightly inferior to the Fife varieties in milling value. The Preston yields less than the Marquis and rusts more, but matures nearly as early and has a greater bushel weight. In milling and baking value it is equal to the Haynes Bluestem.

(6) Few new varieties have in any way compared favorably with Marquis wheat. The early-maturing varieties Prelude and Pioneer escape summer drought in some seasons and are nearly equal to Marquis wheat in milling and baking value. In a limited number of experiments the Kitchener, Ruby, and Kota varieties show promise of being superior to the Marquis.

(7) Of the two widely grown commercial varieties of durum wheat, Arnautka and Kubanka, strains of the Kubanka have proved superior to Arnautka in yield, rust resistance, and milling and baking value.

(8) Other durum varieties in some respects have proved superior to Kubanka. The Peliss has been the highest yielding spring wheat in the western portion of the Great Plains area. The Acme and Monad are superior to all other durum wheats except D–5 in rust resistance and are only slightly inferior to Kubanka in milling and baking value. They have also given higher yields, especially in rust seasons, than most other durum varieties. The D–5 variety is the most rust-resistant variety grown and has yielded only slightly less than Acme and Monad. Its milling and baking value, however, is the poorest of all varieties included in these experiments.

PUBLICATIONS ON CEREALS IN THE GREAT PLAINS AREA.

The results of earlier experiments with cereals in the northern half of the Great Plains area have appeared in the following publications:

BABCOCK, F. R.

1915. Cereal experiments at the Williston Substation. U. S. Dept. Agr. Bul. 270, 36 p., 11 fig.

———, MARTIN, J. H., and SMITH, R. W.

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